

JANUARY 1996

# REPORT NO. 95-13

## NUCLEAR SHIPPING AND STORAGE CONTAINERS WITH DEPLETED URANIUM (DU) SHIELDING DEPARTMENT OF TRANSPORTATION (DOT) CERTIFICATION TESTS

19960806 041

DEFENSE QUALITY INSPECTION

Prepared for:  
Industrial Operations Command  
ATTN: AMSIO-SMA-N  
Rock Island, IL 61299-6000

Distribution Unlimited



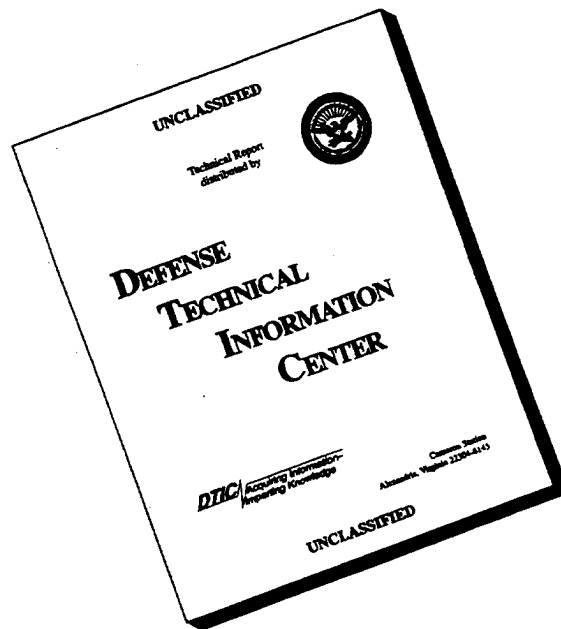
---

---

---

VALIDATION ENGINEERING DIVISION  
SAVANNA, ILLINOIS 61074-9639

# DISCLAIMER NOTICE



**THIS DOCUMENT IS BEST QUALITY AVAILABLE. THE COPY FURNISHED TO DTIC CONTAINED A SIGNIFICANT NUMBER OF PAGES WHICH DO NOT REPRODUCE LEGIBLY.**

### AVAILABILITY NOTICE

A copy of this report will be furnished each attendee on automatic distribution. Additional copies or authority for reprinting may be obtained by written request from Director, U.S. Army Defense Ammunition Center and School, ATTN: SIOAC-DEV, Savanna, IL 61074-9639.

### DISTRIBUTION INSTRUCTIONS

Destroy this report when no longer needed. Do not return.

\*\*\*

Citation of trade names in this report does not constitute an official endorsement.

\*\*\*

The information contained herein will not be used for advertising purposes.

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE

| REPORT DOCUMENTATION PAGE   |       |  |   | Form Approved<br>OMB No. 0704-0188                           |  |
|---|-------|--|---|--|--|
| 1a. REPORT SECURITY CLASSIFICATION<br><b>UNCLASSIFIED</b>   |       |  | 1b. RESTRICTIVE MARKINGS  |  |  |
| 2a. SECURITY CLASSIFICATION AUTHORITY   |       |  | <b>UNLIMITED</b>  |  |  |
| 2b. DECLASSIFICATION / DOWNGRADING SCHEDULE   |       |  |   |  |  |
| 4. PERFORMING ORGANIZATION REPORT NUMBER(S)<br><b>95-13</b>   |       |  | 5. MONITORING ORGANIZATION REPORT NUMBER(S)                                       |  |  |
| 6a. NAME OF PERFORMING ORGANIZATION<br><b>U.S. Army Defense Ammunition Center and School</b>  |       | 6b. OFFICE SYMBOL<br>(if applicable)<br><b>SIOAC-DEV</b>   | 7a. NAME OF MONITORING ORGANIZATION   |  |  |
| 6c. ADDRESS (City, State, and ZIP Code)<br><b>ATTN: SIOAC-DEV<br/>Savanna, IL 61074-9639</b>  |       |  | 7b. ADDRESS (City, State, and ZIP Code)   |  |  |
| 8a. NAME OF FUNDING / SPONSORING ORGANIZATION<br><b>Industrial Operations Command</b>   |       | 8b. OFFICE SYMBOL<br>(if applicable)<br><b>AMSIO-SMA-N</b> | 9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER                                   |  |  |
| 8c. ADDRESS (City, State, and ZIP Code)<br><b>ATTN: AMSIO-SMA-N<br/>Rock Island, IL 61299-6000</b>  |       |  | 10. SOURCE OF FUNDING NUMBERS   |  |  |
|   |       |  | PROGRAM ELEMENT NO.   | PROJECT NO.  | TASK NO.                               |
|   |       |  |   |  | WORK UNIT ACCESSION NO.                |
| 11. TITLE (Include Security Classification)<br><b>Nuclear Shipping and Storage Containers with Depleted Uranium (DU) Shielding<br/>Department of Transportation (DOT) Certification Tests</b>   |       |  |   |  |  |
| 12. PERSONAL AUTHOR(S)<br><b>William R. Meyer</b>   |       |  |   |  |  |
| 13a. TYPE OF REPORT<br><b>Final</b>   |       | 13b. TIME COVERED<br>FROM TO _____                         |   | 14. DATE OF REPORT (Year, Month, Day)<br><b>1996 January</b> |  |
| 15. PAGE COUNT  |       |  |   |  |  |
| 16. SUPPLEMENTARY NOTATION  |       |  |   |  |  |
| 17. COSATI CODES  |       |  | 18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number) |  |  |
| FIELD   | GROUP | SUB-GROUP  |   |  |  |
|   |       |  |   |  |  |
|   |       |  |   |  |  |
| 19. ABSTRACT (Continue on reverse if necessary and identify by block number)  |       |  |   |  |  |
| <p>The U.S. Army Defense Ammunition Center and School (USADACS), Validation Engineering Division (SIOAC-DEV), was tasked by Industrial Operations Command (IOC), AMSIO-SMA-N, to conduct Department of Transportation (DOT) tests on nuclear hazardous waste containers containing concrete and 30mm DU rounds for shielding. Two series of tests were conducted due to fluctuations in radiation levels experienced during the first series of tests. During the second series of tests no fluctuations in radiation were noted with only minor problems experienced with pressure leakage around the base of two of three containers. Except for the leakage noted above, no other problems were experienced with all containers meeting the other requirements for DOT shipping and storage containers. This report contains results of the tests conducted.</p> |       |  |   |  |  |
| 20. DISTRIBUTION / AVAILABILITY OF ABSTRACT<br><input checked="" type="checkbox"/> UNCLASSIFIED/UNLIMITED<br><input type="checkbox"/> SAME AS RPT.<br><input type="checkbox"/> DTIC USERS   |       |  | 21. ABSTRACT SECURITY CLASSIFICATION<br><b>UNCLASSIFIED</b>                       |  |  |
| 22a. NAME OF RESPONSIBLE INDIVIDUAL<br><b>JEROME H. KROHN</b>   |       |  | 22b. TELEPHONE (Include Area Code)<br><b>815-273-8929</b>                         |  | 22c. OFFICE SYMBOL<br><b>SIOAC-DEV</b> |



U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL  
VALIDATION ENGINEERING DIVISION  
SAVANNA, IL 61074-9639

REPORT NO. 95-13

NUCLEAR SHIPPING AND STORAGE CONTAINERS WITH  
DEPLETED URANIUM (DU) SHIELDING  
DEPARTMENT OF TRANSPORTATION (DOT) CERTIFICATION TESTS

TABLE OF CONTENTS

| PART                          | PAGE NO. |
|-------------------------------|----------|
| 1. INTRODUCTION .....         | 1-1      |
| A. BACKGROUND .....           | 1-1      |
| B. AUTHORITY .....            | 1-1      |
| C. OBJECTIVE .....            | 1-1      |
| D. CONCLUSION .....           | 1-1      |
| E. RECOMMENDATIONS .....      | 1-1      |
| 2. ATTENDEES .....            | 2-1      |
| 3. TEST PROCEDURES .....      | 3-1      |
| 4. TEST RESULTS .....         | 4-1      |
| 5. PHOTOGRAPHS .....          | 5-1      |
| 6. DRAWINGS .....             | 6-1      |
| 7. GRAPHS .....               | 7-1      |
| 8. RADIOGRAPHIC SURVEYS ..... | 8-1      |
| 9. APPENDIX .....             | 9-1      |

## PART 1

### INTRODUCTION

A. BACKGROUND. The U.S. Army Defense Ammunition Center and School (USADACS), Validation Engineering Division (SIOAC-DEV), was tasked by Industrial Operations Command (IOC), AMSIO-SMA-N, to conduct Department of Transportation (DOT) tests on nuclear hazardous waste containers. This was a non-government proposal to dispose of excess Depleted Uranium (DU) rounds by incorporating them into the shielding material of nuclear containers. The intended use of these containers is for the commercial sector for shipment and storage of hazardous nuclear waste. If successful, the U. S. Government would realize a cost avoidance in disposal of excess DU rounds.

B. AUTHORITY. This program was conducted IAW mission responsibilities delegated by the U.S. Army Armament, Munitions and Chemical Command (AMCCOM), Rock Island, IL.

C. OBJECTIVE. The objective of these tests was to determine if the proposed containers could meet DOT requirements for shipment and storage of nuclear waste.

D. CONCLUSION. As tested, the containers passed all tests except the .75 atm overpressure test, due to damaged seals and weld leaks around the base of two containers. The first series of tests showed some increases in radiation levels with the second series of tests showing no significant increases in radiation during testing. The design tested during the second series of tests was superior to the first, with very little cracking to the concrete seal that secures the internal vault. This improvement was due to a thicker concrete seal which incorporated the drum rib, and a 25 percent increase in the concrete/hematite used for the shielding.

E. RECOMMENDATIONS:

1. The containers used during production should be certified by the manufacturer to be leak-free at .75 atm or higher and supplied with more durable gaskets that are capable of being reused without leaking to improve the overall leak integrity of the containers.

2. The raw materials should be supplied with the container for sealing the internal cavity to ensure the seal integrity equals that of the tested containers.

PART 2

27-28 SEPTEMBER AND 11 OCTOBER 1995

ATTENDEES

William R. Meyer  
General Engineer  
DSN 585-8090  
815-273-8090

Director  
U.S. Army Defense Ammunition Center  
and School  
ATTN: SIOAC-DEV  
Savanna, IL 61074-9639

Bradley J. Haas  
Mechanical Engineer  
DSN 585-8336  
815-273-8336

Director  
U.S. Army Defense Ammunition Center  
and School  
ATTN: SIOAC-DEV  
Savanna, IL 61074-9639

Jim Rohler  
DSN 793-4714  
309-782-4714

Commander  
Industrial Operations Command  
ATTN: AMSIO-SMA-N  
Rock Island, IL 61299-6000

Paul Janeczek  
319-386-3533

Energy and Environmental Technology  
Company  
2228 Emerald Drive  
Davenport, IA 52804

## PART 3

### TEST PROCEDURES

The following tests were extracted in part from Title 49 Code of Federal Regulations (CFR), section 173.401, Radioactive Materials.

- 1) Design requirements for Type A packages section 173.412
- 2) Type A packaging tests section 173.465.
- 3) The vibration test was extracted from Federal Standard 101, Method 5019.

A. HOT/COLD TESTS. The container was designed so that containment and shielding was maintained during transport and storage in a temperature range of -40 degrees Celsius (-40 degrees Fahrenheit) and 70 degrees Celsius (158 degrees Fahrenheit) with account being taken of the possibility of brittle fracture.

B. PRESSURE TEST. The container was designed so that the containment system retained its radioactive contents under the reduction of ambient pressure to .25 kilograms per square centimeter (3.5 pounds per square inch). Note: For smaller containers, vacuum testing simulates design requirements; for large containers, pressure testing to .75 atm simulates design requirements.

C. WATER SPRAY TEST. The water spray test precedes each test or test sequence. The water spray test simulates exposure to rainfall of approximately 5 centimeters (2 inches) per hour for at least one hour. The time interval between the end of the water spray test and the beginning of the next test is such that the water has soaked-in to the maximum extent without appreciable drying of the exterior of the specimen. In the absence of evidence to the contrary, this interval

may be assumed to be two hours if the water spray is applied from four different directions simultaneously. However, no time interval may elapse if the water spray is applied from each of the four directions consecutively. Note: This test is designed to pre-condition containers that are susceptible to moisture prior to testing such as cellulose materials; i.e., cardboard, pressboard, etc. For metal containers that are impervious to moisture, one test was conducted with the balance of tests passing by analogy.

D. FREE DROP TEST. The free drop test consisted of a fall onto the target in a manner that caused maximum damage to the safety features being tested and for packages weighing 5,000 kilograms (11,000 pounds) or less, the distance of the fall measured from the lowest point of the packaging to the upper surface of the target was not less than 1.2 meters (4 feet).

Note: Orientations of the package that cause the maximum damage to the container are as follows:

- (1) Flat to the container side along the weld seam and in line with the bolt retaining the package lid.
- (2) Flat to the package lid and cover retaining ring and bolt.
- (3) 45 degrees to the package lid/side in line with the weld seam and bolt securing the package lid.

E. COMPRESSION TEST. The compression test lasted for a period of at least 24 hours and consisted of a compressive load equivalent to the greater of the following.

- (1) Five times the weight of the actual package or
- (2) 1300 kilograms per square meter (265 pounds per square foot) multiplied by the vertically projected area of the package. The compressive load was applied uniformly to two opposite sides of the packaging specimen, one was the base on which the package would normally stand.

F. PENETRATION TEST. For the penetration test, the packaging specimen was placed on a rigid, flat, horizontal surface that did not move while the test was being performed. The test consisted of a bar 3.2 centimeters (1.25 inches) in diameter, with a hemispherical end weighing 6 kilograms (13.2 pounds), being dropped with its longitudinal axis vertical, onto the center of the weakest part of the packaging specimen so that, if it penetrated far enough, it will hit the containment system. The bar must not be deformed by the test and the distance of the fall of the bar measured from its lower end to the upper surface of the packaging specimen was not less than 1 meter (3.3 feet).

G. VIBRATION TEST. The vibration test is not part of the DOT requirements; however, it was added to the test program to verify the transportability of these nuclear containers. The repetitive shock test was conducted IAW Method 5019, Federal Standard 101. The test procedure was as follows: the test specimens (3 samples) were placed on, but not fastened to, the vibration platform. With the specimens in position, the platform was vibrated at 1/2-inch amplitude (1-inch double amplitude) starting at a frequency of approximately 3 cycles per second. The frequency was steadily increased until the package left the platform. The resonant frequency was achieved when a 1/16-inch-thick feeler gage momentarily slid freely between every point on the specimen in contact with the platform at some instance during the cycle or a platform acceleration achieves  $1 \pm 0.1$  Gs. Unless failure occurs, the total time of vibration is one hour.

H. PASS/FAIL REQUIREMENT. When the package is subjected to the tests specified in Title 49, CFR, section 173.465, or evaluated against these tests by any of the methods authorized by Title 49, CFR, section 173.461, the packaging will prevent the following:

- (1) Loss or dispersal of the radioactive contents and
- (2) Any significant increase in the radiation levels recorded or calculated at the external surfaces before and after testing. Title 49, CFR, section 173.401, Radioactive Materials, does

not define what significant increases in radiation will be; therefore, a 20 percent increase was selected to conform to Department of Energy (DOE), Westinghouse Inc., Hanford, Washington pass/fail requirements. To verify the pass/fail requirements set forth above, a florescent dust inspection test was used to verify no loss of contents and radiographic surveys were used to verify radiation levels before and after testing.



## PART 4

### TEST RESULTS

All containers tested used inert 30mm ammunition in lieu of 30mm DU rounds to avoid disposal of hazardous waste test samples. The length of the inert rounds were approximately 3 inches versus 5.5 inches for the DU rounds. All containers tested were furnished to USADACS by suppliers recommended by Stan A. Huber Consultants, Inc.

A. HOT/COLD TEST. During both the -40 degrees Fahrenheit cold test and the 158 degrees Fahrenheit hot test, no problems were encountered. This test was conducted to ensure compatibility of materials and ascertain the potential for brittle fracture at extreme temperatures. Following testing, all four containers had no leakage of contents or significant increases in radiation.

B. COMPRESSION TEST. The 24-hour compression test was conducted at 7,500 pounds. After the first compression test, the container had a small superficial crack on the concrete seal that secures the internal cavity (see photograph in Part 5). No cracks were detected during the second test. Following testing, neither container had any leakage of florescent dust or significant increases in radiation.

C. VIBRATION TEST. During the first series of tests, one container went through three 1-hour vibration tests with no problems encountered. During the second series of tests, three containers were tested for 1 hour each. The orientation during all tests was in the upright position, simulating normal transportation conditions. During the second series of tests, one container developed minor damage to the lower base rim due to the peening action of the vibration table during periods in which the sample reached resonant frequency. Typical accelerations during this test were 1 to 2 Gs in the vertical axis and 0.5 to 1.0 Gs in the

longitudinal and lateral axis, (see graphs in Part 7). Following testing, all four containers experienced no loss of florescent dust or significant increases in radiation.

D. PRESSURE TEST. During the first series of tests, one container with a new seal was pressurized to 11.5 psi with helium to simulate a .75 atm overpressure. After pressurization, a mass spectrometer was used to inspect all weld seams as well as the lid gasket sealing area. No leaks were encountered at the  $1 \times 10^{-6}$  cc/he/sec/11.5 psi sensitivity level. During the second series of tests, three containers were pressurized as described above and again inspected with a mass spectrometer. All three containers showed some leakage of the gasket around the rim sealing area. This leakage was due to reuse of previously-used gaskets, with all gaskets showing some damage prior to this test. Two containers also had some leakage around the bottom weld seam.

E. WATER SPRAY TEST. During the first series of tests, one container was placed into a water spray chamber and subjected to a simulated rainfall of 2 inches per hour from four different angles, 90 degrees apart. The duration of the test was 1 hour with the container passing this test with no problems encountered. This test was not repeated during the second series of tests due to the imperviousness of moisture on metal containers.

F. PENETRATION TEST. During the first series of tests, one container was subjected to a 13.4-pound, 1.25-inch diameter steel bar with a hemispherical end dropped from 3.3 feet. The first impact was to the container lid with a small permanent deformation noted. The second impact was to the container body with no indentation occurring. The container passed both tests with no problems encountered. This test was not repeated during the second series of tests due to the lack of damage noted during the first series of tests.

G. FREE FALL DROP TESTS. Three drop tests were conducted from four feet in the following order for both series of tests:

- (1) Flat to the container side with impact on the weld seam.
- (2) Flat to the container lid.
- (3) 45 degrees to the container lid and body.

During the first series of tests, one container was dropped twice with the first two orientations listed above and the other container was dropped once 45 degrees to the lid. During the first series of drops, cracks to the concrete shielding were noted on both containers with no loss of contents (see photographs in Part 5). During this drop test, the container experienced 24 Gs when dropped flat to its side, 24 plus Gs when dropped flat to the container lid and 22 Gs vertical and 17 Gs longitudinal when dropped 45 degrees to the lid (see graphs in Part 7).

During the second series of tests with the drop flat to the container side, only minor damage to the container body was noted with more damage to the rim, bolt, and lid as would be expected. After the drop flat to the container lid, approximately one-third of the lid rim was rolled up and under the drum rim with the drum edge collapsed and flush with the concrete interior. After the drop 45 degrees to the lid and side, the lid retaining ring popped off, with the cover remaining intact and only minor concrete pulverization to the impact area. The second series of tests did not experience the same concrete cracking as noted during the first series of tests with only minor damage noted to the concrete after testing (see photographs in Part 5).

Following all impacts, the lids were removed and inspected with a black light for leakage of florescent dust located in the internal cavities, none was detected. During the first series of tests, several sites showed increases in radiation above 20 percent and believed to be due to the shifting of the inert load during testing; however, no significant radiation increases were noted during the second series of tests.

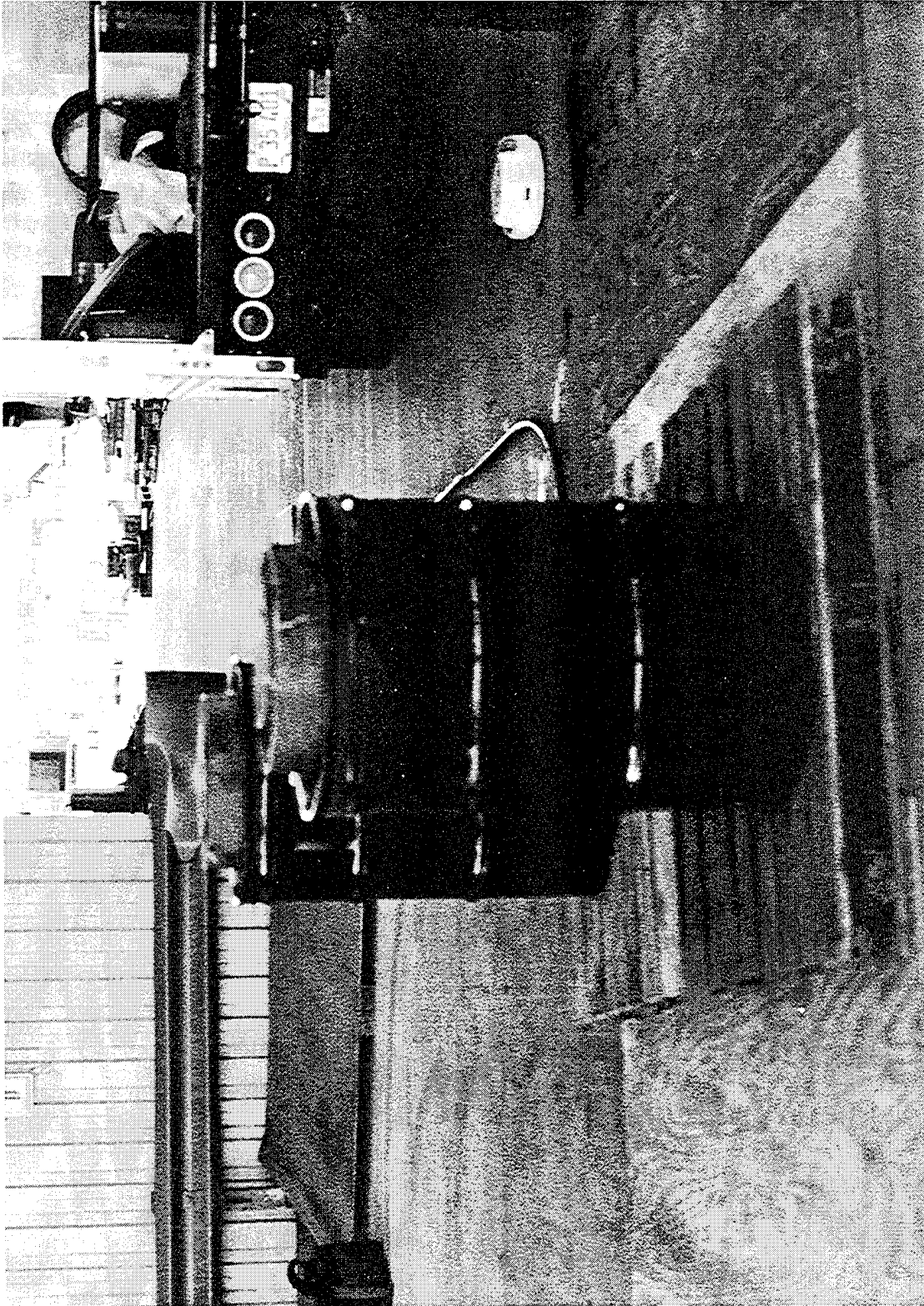
H. RADIOGRAPHIC SURVEYS. Before and after each test, the shield integrity was checked at 20 different sites on the exterior of each container to determine if any deterioration had taken place (see drawing in Part 6).

During the first series of tests, a 33 curie source was used to inspect each container. Following testing, both samples showed significant increases in radiation above 20 percent at two locations. Container 1 (yellow) at site 9 went from 225 mr to 300 mr after testing and container 2 (red) at site 11 went from 30 mr to 55 mr. Three other sites (1, 2, and 3) on container 2 (red) had radiation fluctuations between 2 and 5.5 mr and are not considered significant due to their low mr readings as well as being a factor of 100 smaller than the hottest spots on the containers; namely, the center of the drum at sites 6, 9, 12, and 15. From the radiographic surveys it was concluded that the containers failed radiation tests due to settling of the inert load (steel shot) and not because of the container design. As an example, when the container was rotated 90 degrees, increases and decreases in radiation were noted as the steel shot shifted inside the cavity. During the second series, a resin was added to the steel shot to solidify the inert load with an 8 curie source being used to inspect the containers. By reviewing the radiographic readings located in Part 8 it can be noted that no significant increases of radiation occurred during any phase of testing, with many readings less than 5 mr during all phases of testing. Higher readings were noted around the 360 degree band on the center one-third of the container, where the shielding is thinnest, with readings in the 40 to 50 mr range. During the second test, none of the readings exceeded the 20 percent increase allowed under the pass/fail requirement. It should be noted that the source used during the second test was approximately 5.5 times weaker than the first test to reduce the radiation hazard (exposure) to workers. As a result, the lowest readings (top and bottom) of the containers with the thickest shielding were reported as less than 5 mr or the lowest detectable reading on the instrumentation being used. This approach was also taken to minimize operator error, fluctuations in

instrumentation sensitivity, position of instrument in relation to the spot being monitored, and slight changes in the position of the source during testing, all of which have a major impact on low-level mr readings. Again, these low readings become insignificant when compared to the hottest spots on the container bodies, where personnel would experience the greatest health risk.

PART 5

PHOTOGRAPHS



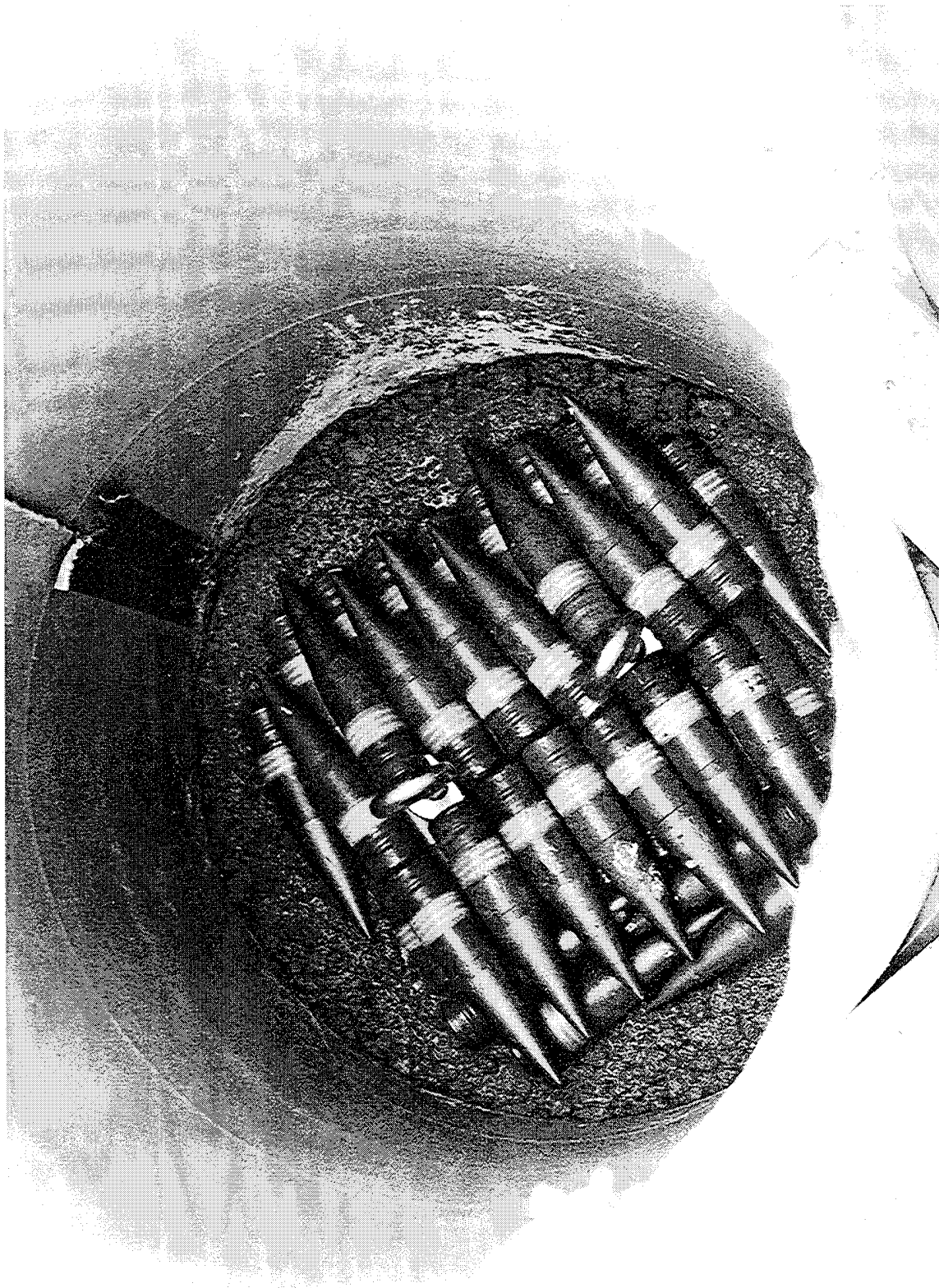
U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL -  
SAVANNA, IL

AO317-SCN95-31-2591. This photos shows an overall view of construction of test samples.

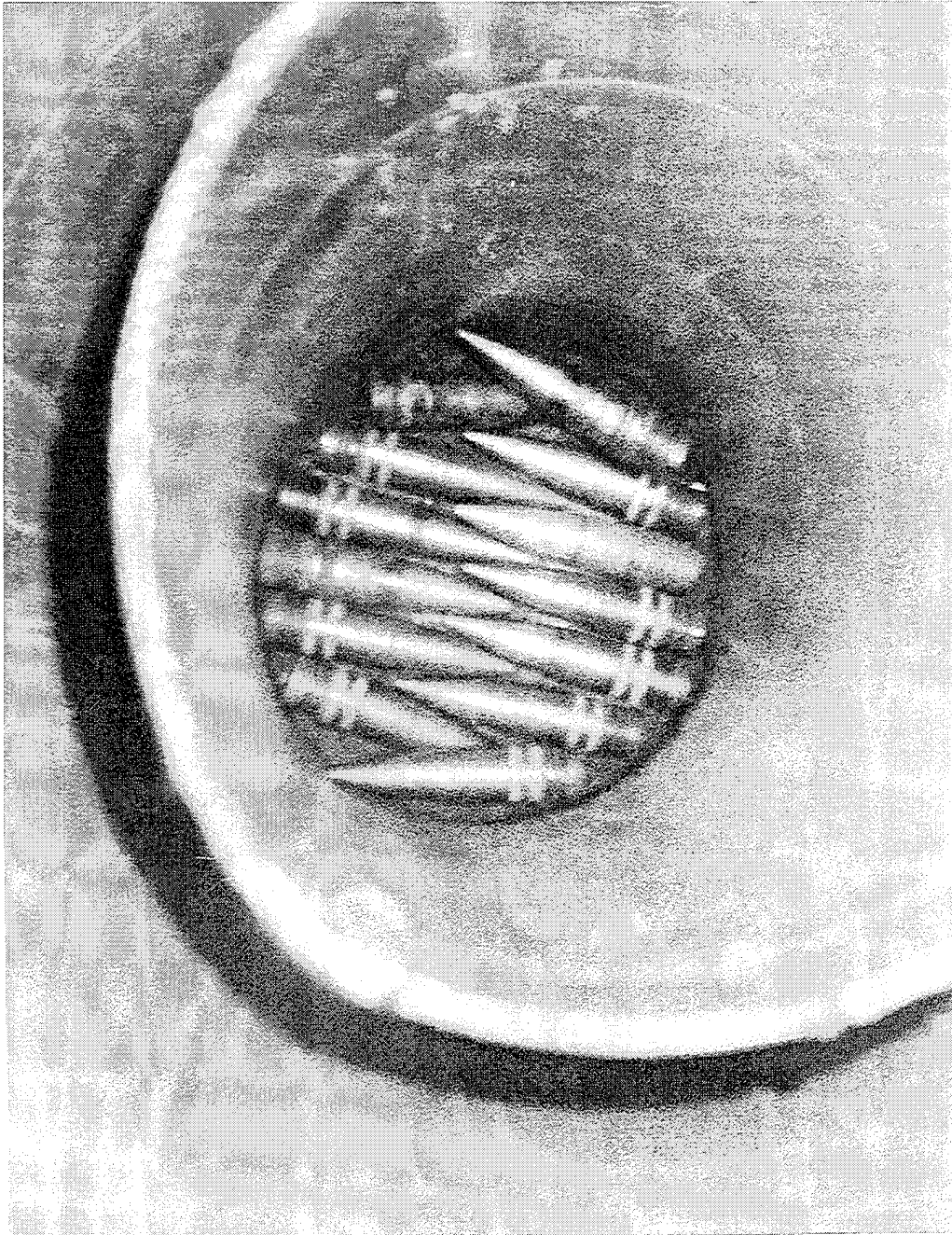


|  |   |  |
|--|---|--|
|  | U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL -<br>SAVANNA, IL |  |
| AO317-SPN96-28-668. This photo shows a closeup view of the sono tubes used to retain the concrete shielding. |   |  |





|  |   |  |
|--|---|--|
|  | U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL -<br>SAVANNA, IL |  |
| AO317-SCN95-31-2599. This photo shows a closeup view of the fabrication of the cover used to encapsulate the hazardous waste cavity. |   |  |



|   |   |  |
|---|---|--|
|   | U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL -<br>SAVANNA, IL |  |
| AO317-SPN96-28-673. This photo shows a closeup view of 30MM inert ammunition at the bottom of the internal cavity prior to enclosure with concrete. |   |  |

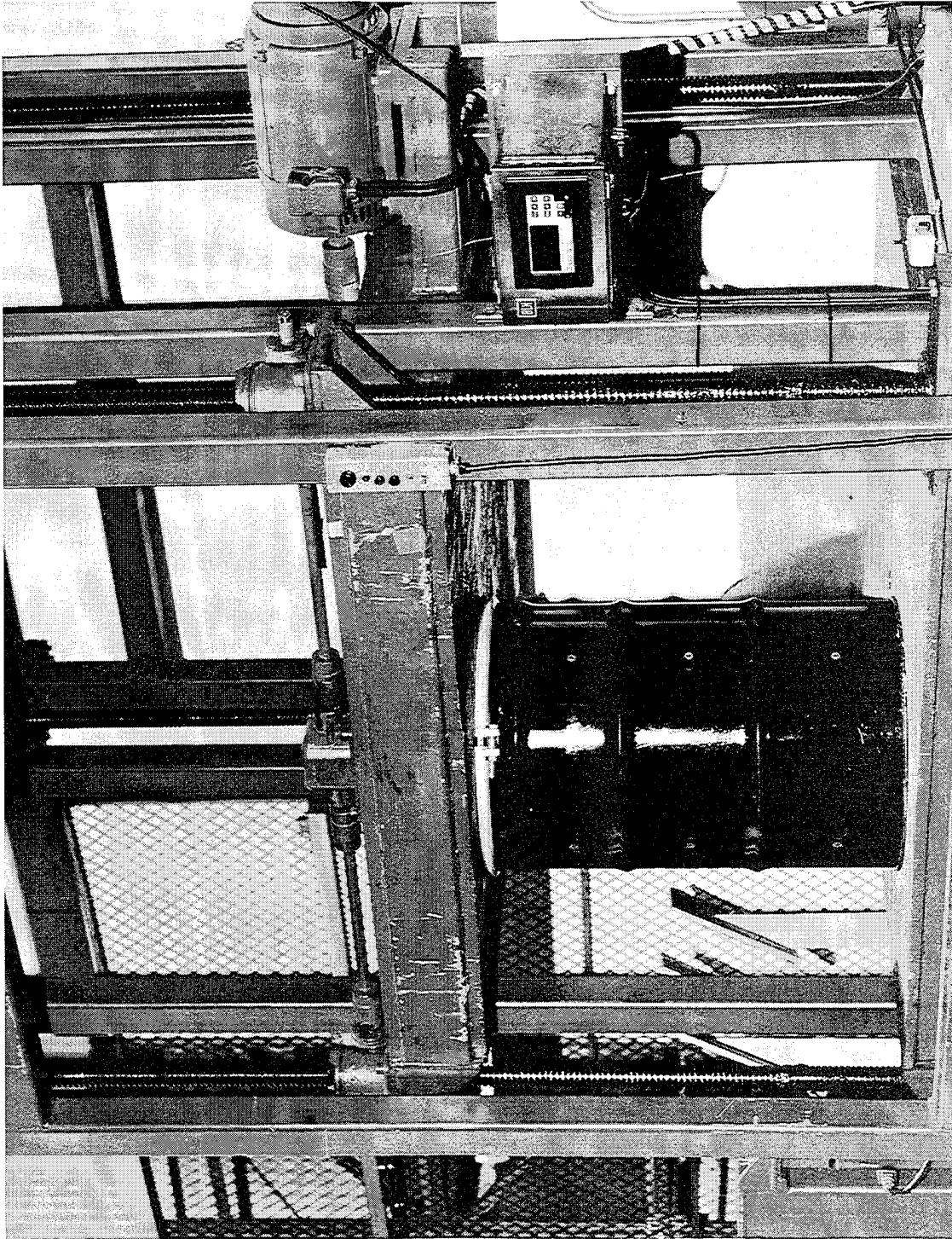


|   |   |  |
|---|---|--|
|   | U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL -<br>SAVANNA, IL |  |
| AO317-SPN96-28-694. This photo shows the closeup view of the test port used to insert the radiation source for radiographic measurements. |   |  |

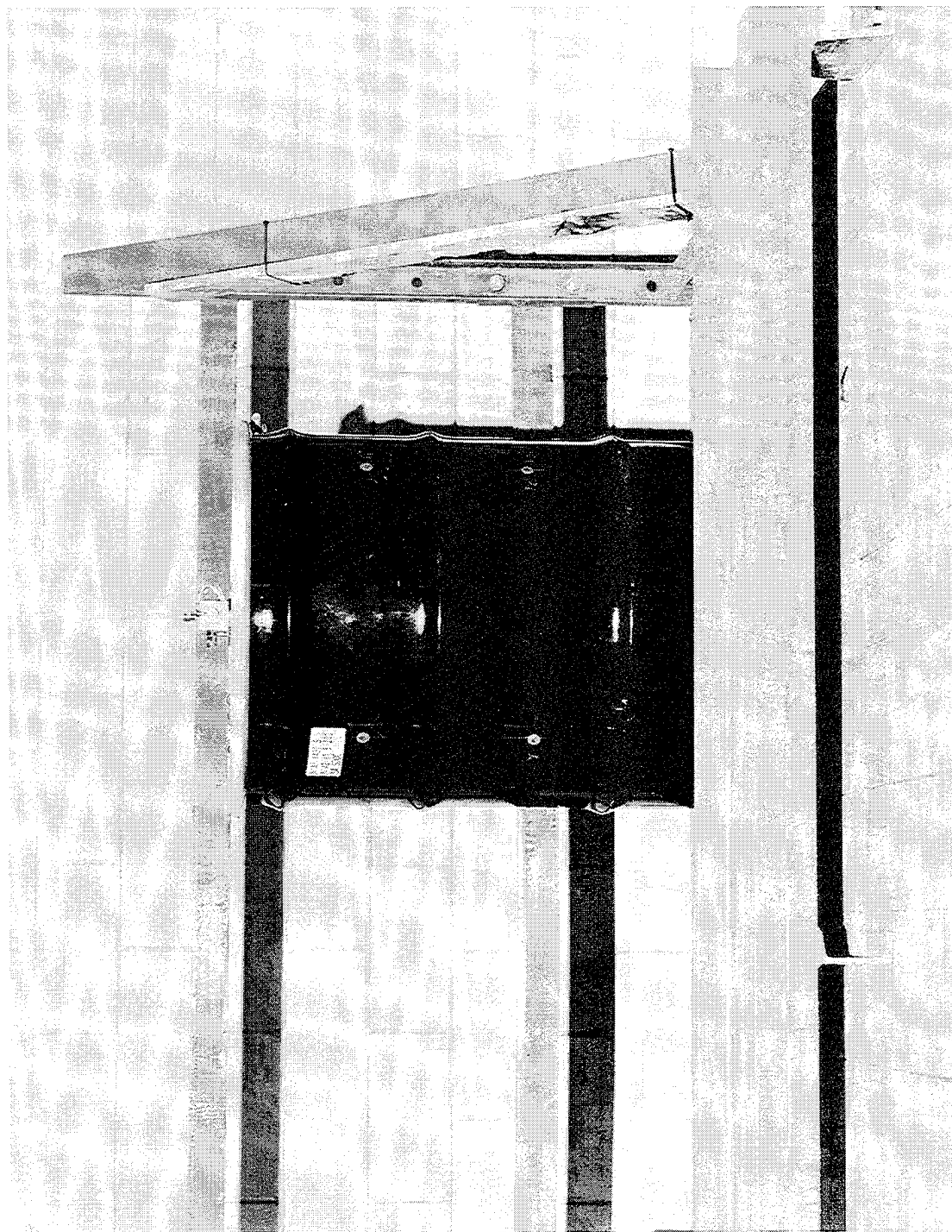


|  |   |  |
|--|---|--|
|  | U.S. ARMY DEFENSE AMMUNITION CENTER AND<br>SCHOOL - SAVANNA, IL |  |
| USADACS-DEV-95-13-01. This photo shows a closeup view of one test sample following removal from the cold soak chamber at -40 degrees Fahrenheit. |   |  |





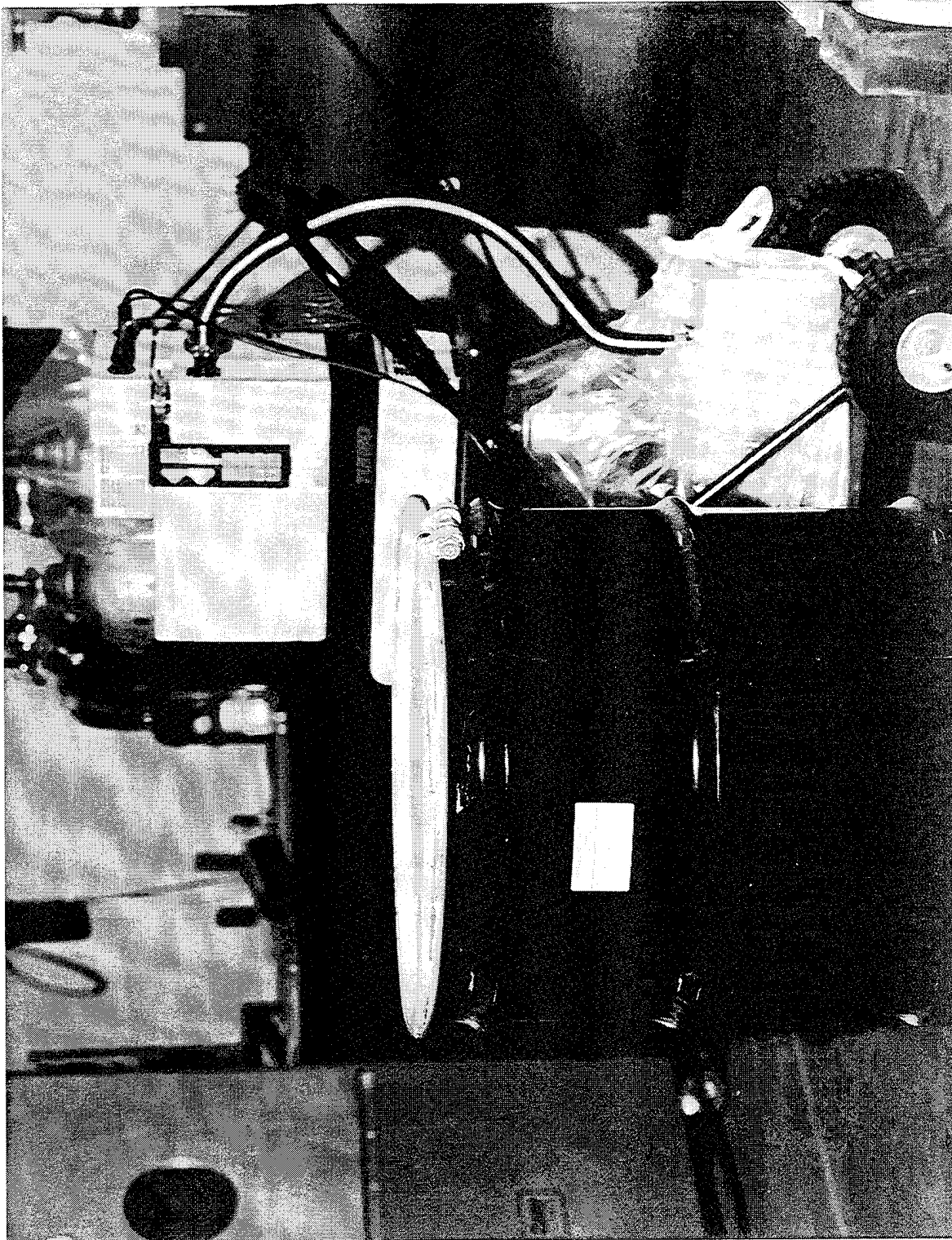
|   |   |  |
|---|---|--|
|   | U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL -<br>SAVANNA, IL |  |
| AO317-SCN95-173-2155. This photo shows an overview of the compression test conducted on the hazardous waste containers. |   |  |



|   |   |  |
|---|---|--|
|   | U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL -<br>SAVANNA, IL |  |
| AO317-SCN95-173-2242. This photo shows an overview of the vibration test used during these series of tests.<br>Note the accelerometer block on top of the test sample with vertical and horizontal transducers installed. |   |  |



|  |   |  |
|--|---|--|
|  | U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL -<br>SAVANNA, IL |  |
| AO317-SCN95-173-2164. This photo shows the test sample prior to placement into the water soak chamber. |   |  |

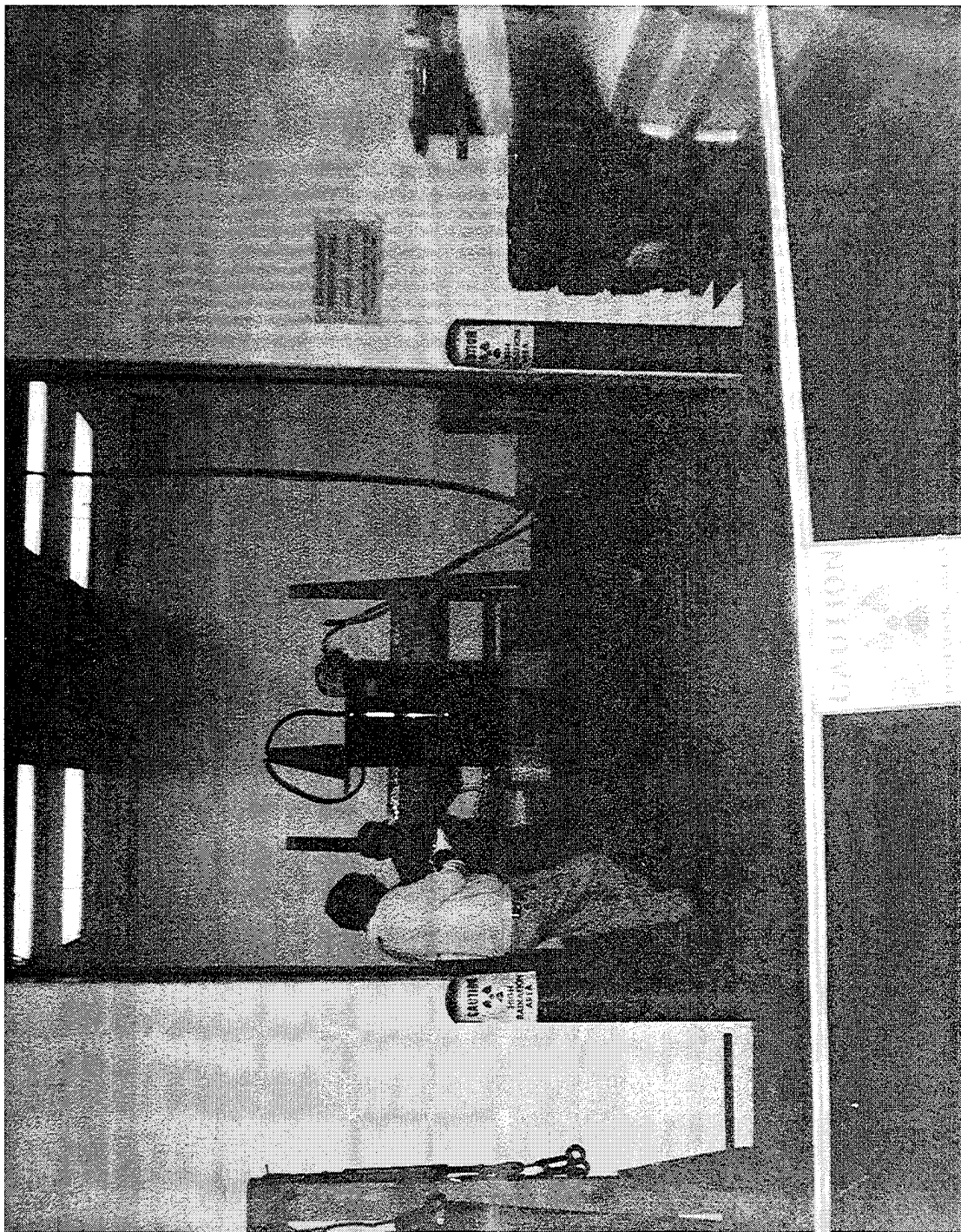


|  |   |  |
|--|---|--|
|  | U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL -<br>SAVANNA, IL |  |
| AO317-SCN95-173-2245. This photo shows the test setup used to perform leak testing on the hazardous waste containers. Note the helium mass spectrometer with sampling probe in the background. |   |  |





|  |   |  |
|--|---|--|
|  | U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL -<br>SAVANNA, IL |  |
| USADACS-DEV-95-13-02. This photo shows an overview of the test setup used during drop tests. |   |  |

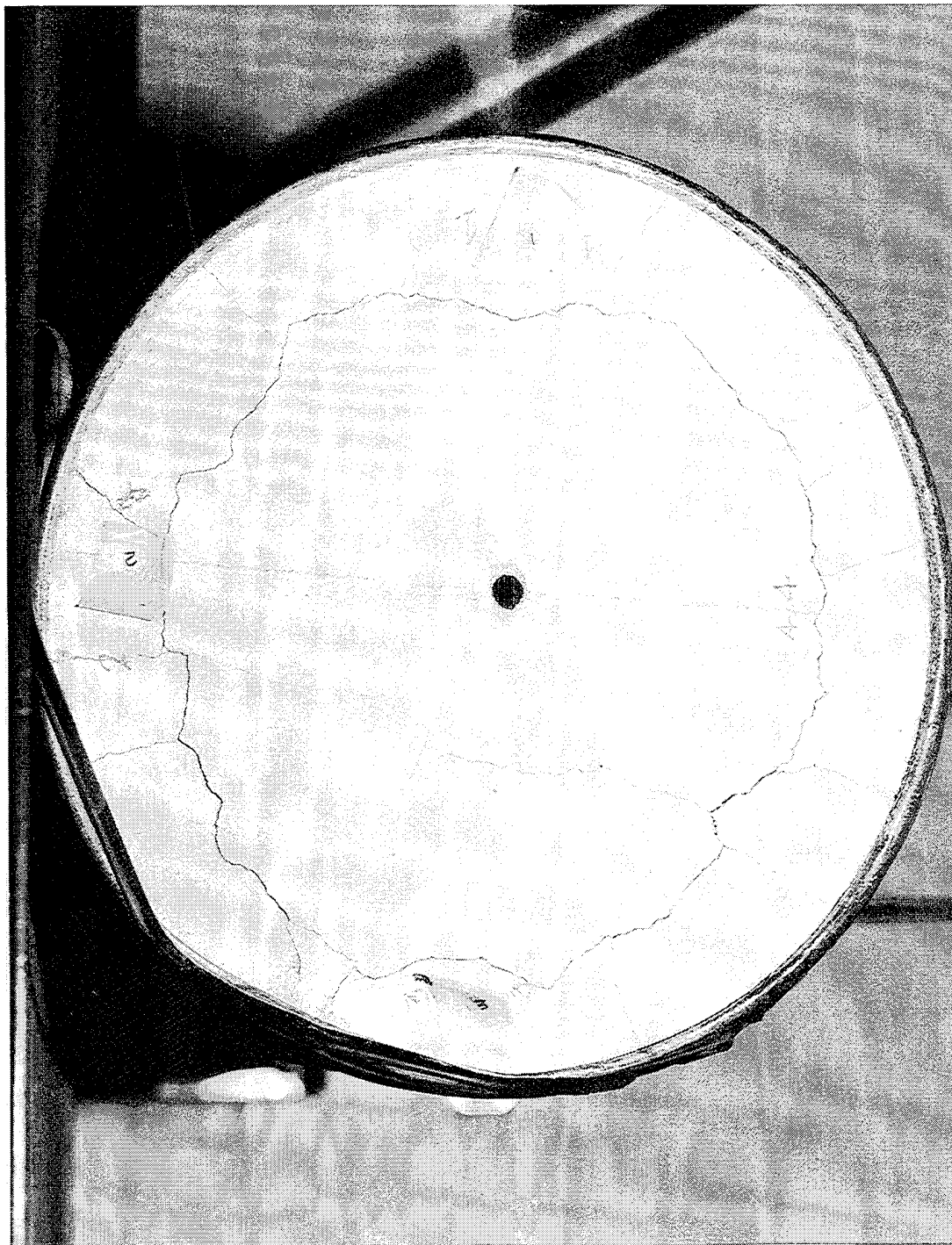


U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL -  
SAVANNA, IL

USADACS-DEV-95-13-03. This photo shows an overview of radiographic surveys being conducted on test samples both before and after testing.

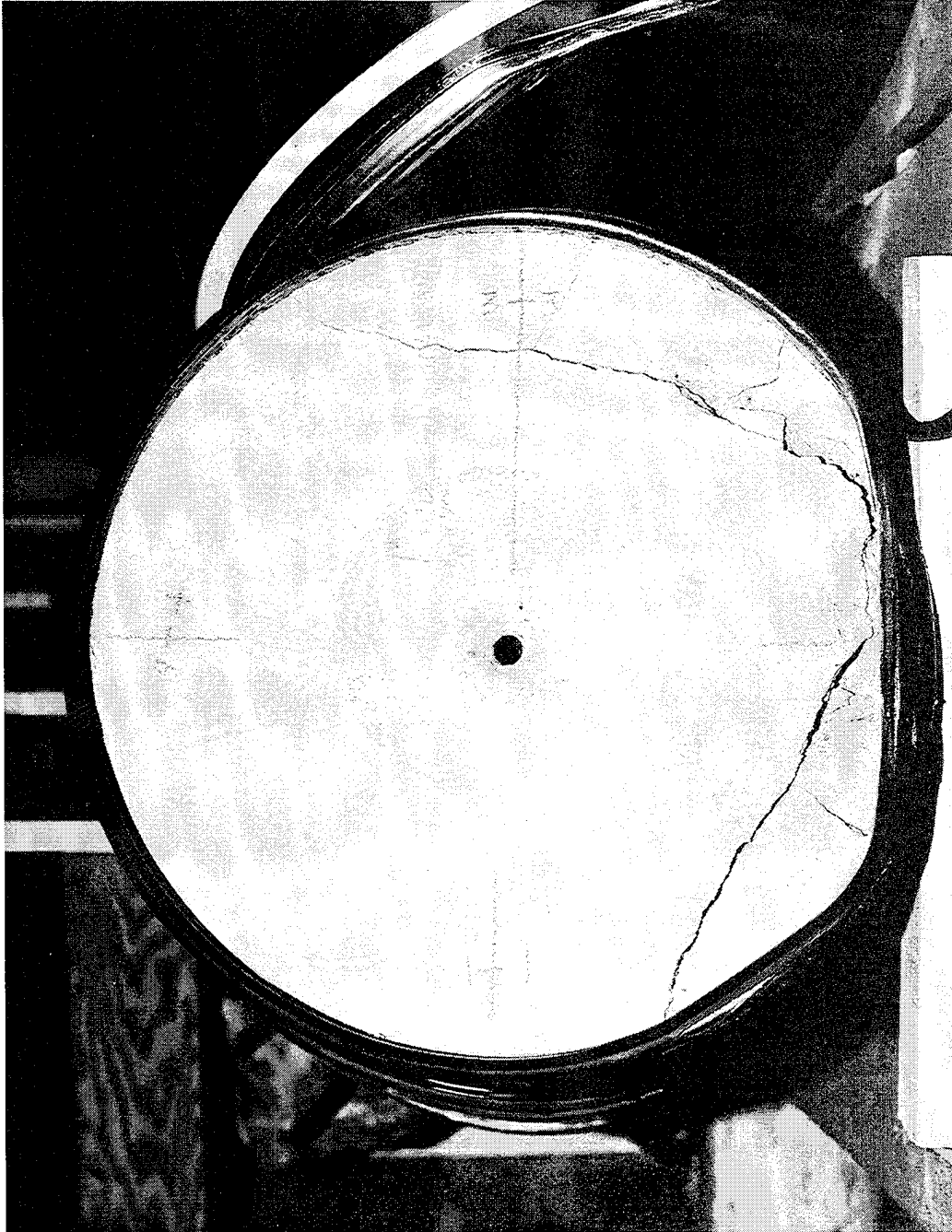


|  |   |  |
|--|---|--|
|  | U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL -<br>SAVANNA, IL |  |
| AO317-SCN95-173-2152. This photo shows a crack that developed in a container during test no. 1 after the compression test. |   |  |

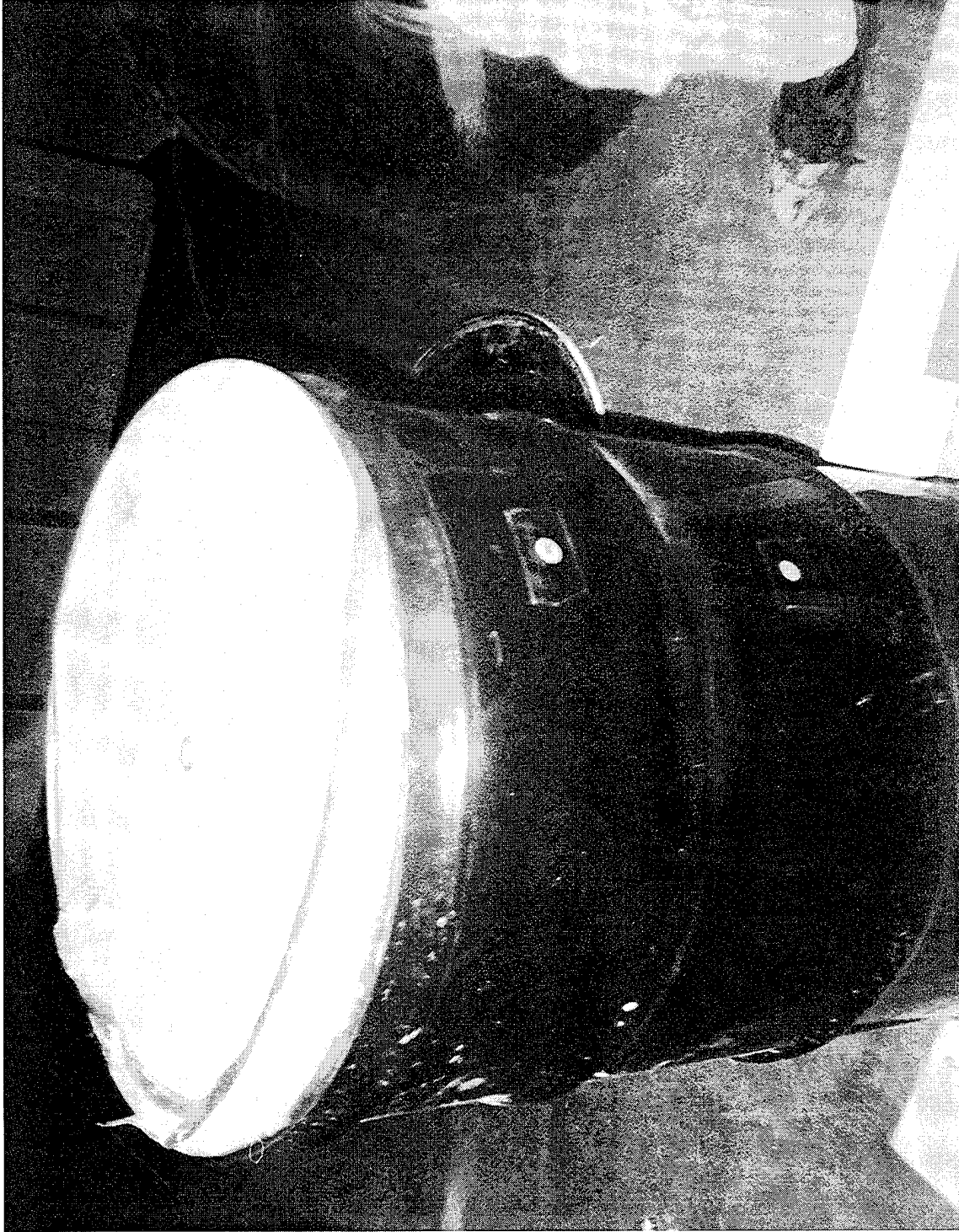


|  |   |  |
|--|---|--|
|  | U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL -<br>SAVANNA, IL |  |
| AO317-SCN95-173-2249. This photo shows damage sustained after two drops flat to the container side as well as flat to the top of the container during the first series of tests. |   |  |



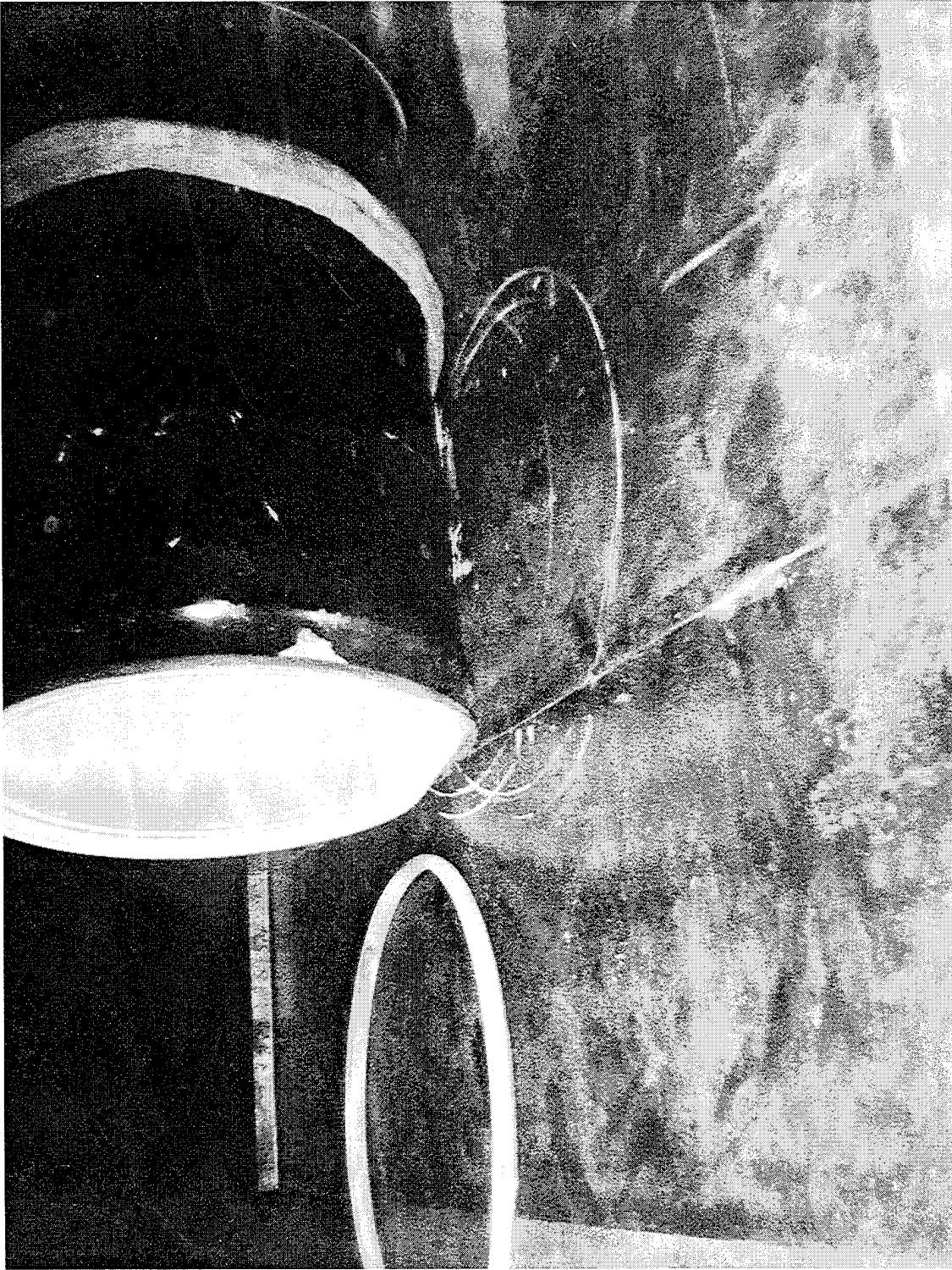


|  |   |  |
|--|---|--|
|  | U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL -<br>SAVANNA, IL |  |
| AO317-SCN95-173-2248. This photo shows damage to the side of the container resulting after the 45 degree angle drop test during the first series of tests. |   |  |

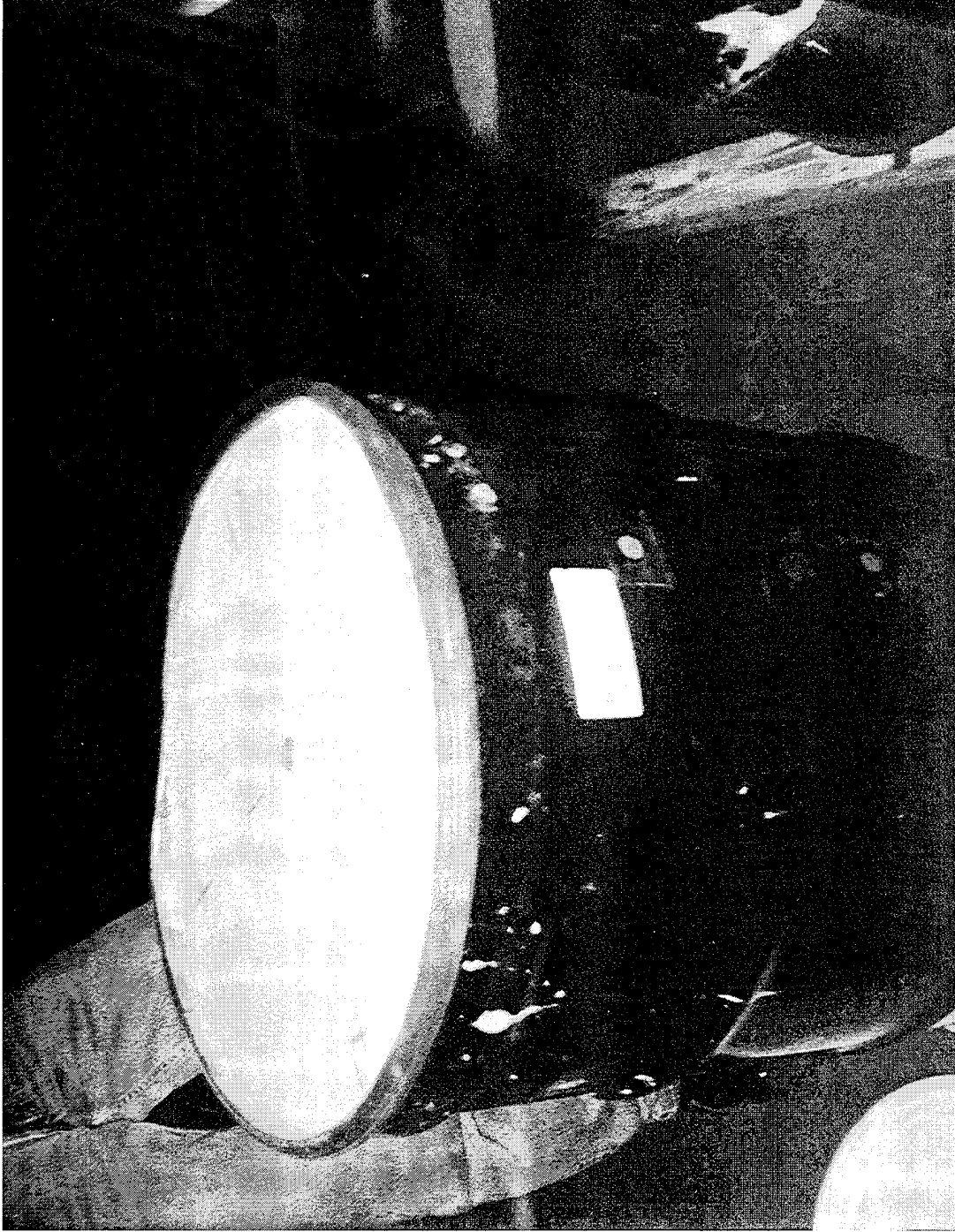


|  |   |  |
|--|---|--|
|  | U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL -<br>SAVANNA, IL |  |
|--|---|--|

|  |
|--|
| USADACS-DEV-95-13-04. This photo shows damage to the container after the vertical drop test during the second series of tests. |
|--|



|   |   |  |
|---|---|--|
|   | U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL -<br>SAVANNA, IL |  |
| USADACS-DEV-95-13-05. This photo shows damage to the container after the 45 degree angle drop test during the second series of tests. |   |  |



|   |   |  |
|---|---|--|
|   | U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL -<br>SAVANNA, IL |  |
| USADACS-DEV-94-13-06. This photo shows damage to the container after the 45 degree angle drop test during the second series of tests. |   |  |

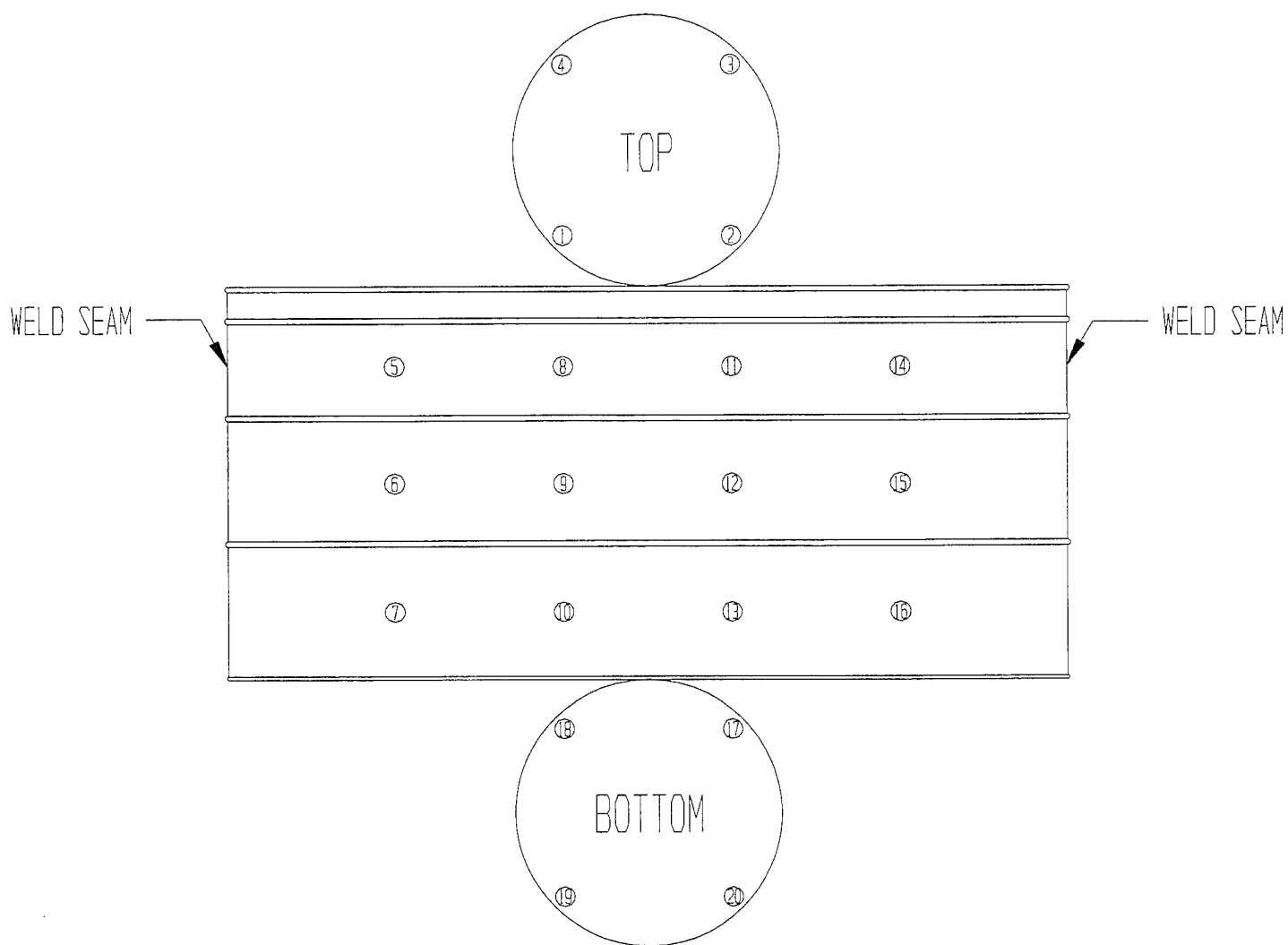




|   |   |  |
|---|---|--|
|   | U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL -<br>SAVANNA, IL |  |
| USADACS-DEV-94-13-07. This photo shows damage to the container after the 45 degree angle drop test during the second series of tests. |   |  |

PART 6

DRAWINGS

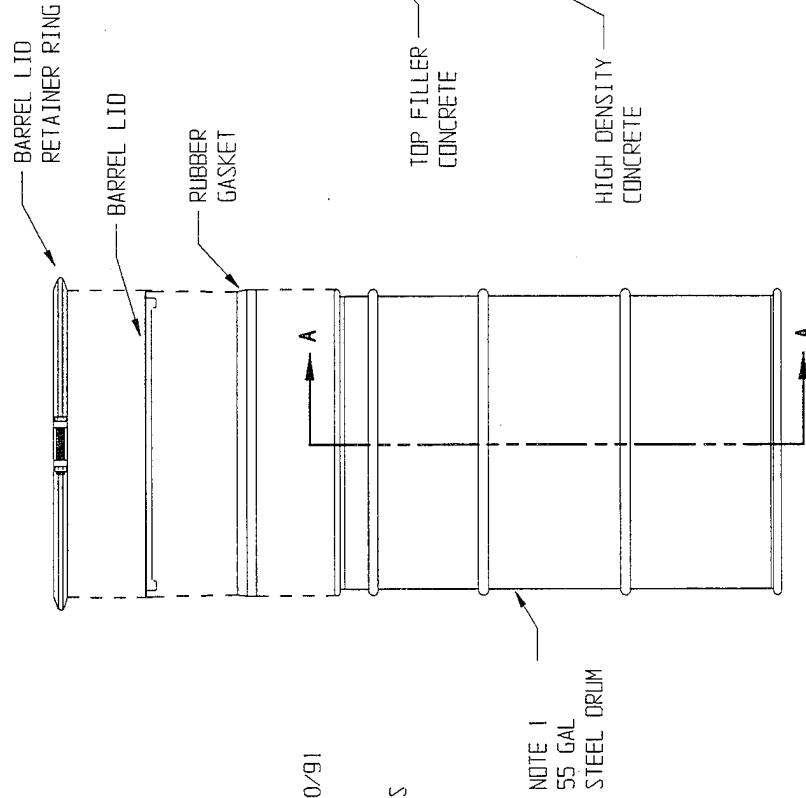


DEPLETED URANIUM SHIELDED  
CONTAINER RADIATION TEST POINTS

| REVISION |                        |          |
|----------|------------------------|----------|
| LTR      | DESCRIPTION            | DATE     |
| -        | PRODUCT BASELINE       | 96-05-06 |
| A        | ADMINISTRATIVE CHANGES | 96-05-20 |

# NOTES:

- 55 GAL DRUM WILL CONTAIN 283-30MM INERT ROUNDS ENCASED IN CEMENT. (NUMBER OF ROUNDS WILL BE LOWER FOR PRODUCTION DRUM DUE TO THE INCREASE IN SIZE OF PRODUCTION ROUNDS. SEE DRAWING SHEET 6). 55 GAL STEEL DRUM SPEC: UN PART# A21Y1.5/150/91 GSA PART# C05507
- CONCRETE MIX SPECIFICATIONS SEE SHEET 8.



NOTE 1  
55 GAL  
STEEL DRUM

THE DRAWING DEPICTS THE ITEMS AS TESTED AND ARE NOT TO BE USED FOR PRODUCTION PURPOSES. THE U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL (USADACS) AND THE U.S. GOVERNMENT ASSUME NO LIABILITY.

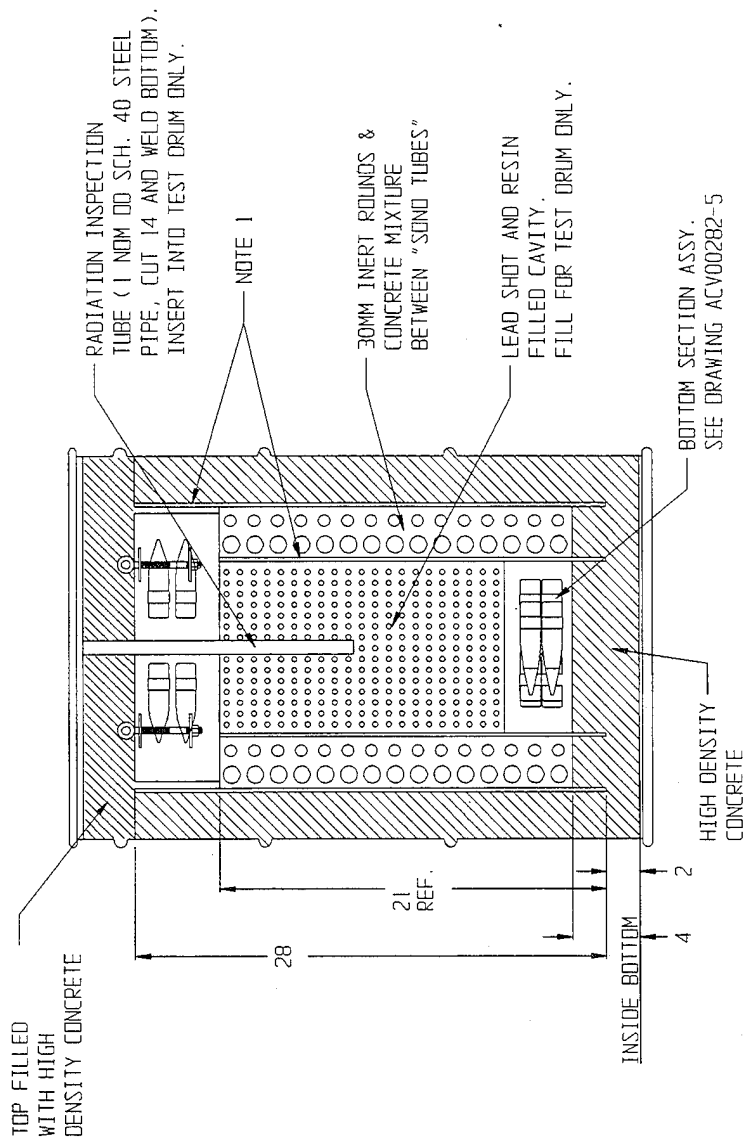
PART NO ACV00282-1

|  |   |  |  |
|--|---|--|--|
| DATE<br>96-01-17   |   | DESIGN ACTIVITY<br>U.S. ARMY<br>INDUSTRIAL OPERATIONS COMMAND<br>DEFENSE AMMUNITION CENTER AND SCHOOL<br>SAVANNAH, ILLINOIS 61074-9639 |  |
| OPTION<br>SKK  | CHIEF<br>WM   | PROD ENGR<br>W. MEYER  |  |
| STUD-DRY<br>WRM LHK  | SUBMITTED<br>THOMAS J. MICHELS<br>CHIEF, SUPPLY ENGINEERING DIV |  |  |
| APPROVED BY ENTER OF CONSIGNING<br>GENERAL: U.S. ARMY MATERIAL COMMAND (AMC) |   |  |  |
| WILLIAM F. ERNST<br>CHIEF, LOGISTICS ENGINEERING OFFICE                      |   |  |  |
| GARY W. ABRISZ   |   |  |  |
| TEST CONTAINER FOR<br>30MM INERT DEPLETED<br>URANIUM ROUNDS                  |   | SIZE<br>C  |  |
| CASE CODE<br>28620   |   | UNIT WT<br>SCALE NONE  |  |
| ACV00282   |   | SHEET 1 OF 8   |  |

DISTRIBUTION STATEMENT  
NOT APPROVED FOR PUBLIC RELEASE;  
PROPRIETARY DRAWING.  
DO NOT DISTRIBUTE.

# DRAWING OF TEST DRUM

1. 1/4 INCH THICK FIBER FORM "SOND TUBE" FOR SPECIFICATIONS, SEE DRAWING ACV00282-7.



THE DRAWING DEPICTS THE ITEMS AS TESTED AND ARE NOT TO BE USED FOR PRODUCTION PURPOSES. THE U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL (USADACS) AND THE U.S. GOVERNMENT ASSUME NO LIABILITY.

PART NO ACV00282-2

[illegible]

DISTRIBUTION STATEMENT.

NOT APPROVED FOR PUBLIC RELEASE;  
PROPRIETARY DRAWING.  
DO NOT DISTRIBUTE.

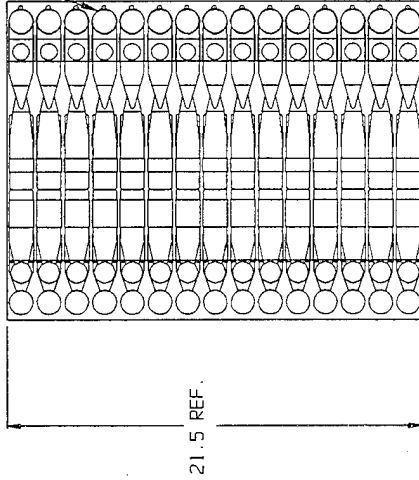
| REVISION |                        |             |
|----------|------------------------|-------------|
| LTR      | DESCRIPTION            | DATE        |
| -        | PRODUCT BASELINE       | 96-05-06    |
| A        | ADMINISTRATIVE CHANGES | 96-05-20    |
|          |                        | W. R. MEYER |

# NOTE:

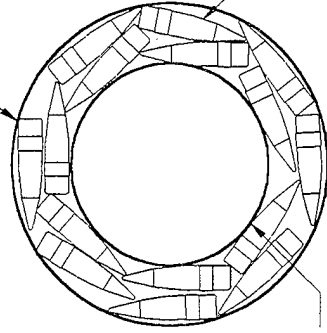
- DRAWING SHOWS 30MM INERT ROUND LAYERS AND CONCRETE MIXTURE BETWEEN THE TWO "SOND TUBES"; 15 LAYERS ARE REQUIRED, AS TESTED THE ROUND LAYERS WERE NOT AS UNIFORM AS DEPICTED.

## NOTE 1

225 TOTAL 30MM INERT ROUNDS SUSPENDED IN CONCRETE, PLACED BETWEEN THE TWO "SOND TUBES".



16 DIA.  
"SOND TUBE"



10 DIA.  
"SOND TUBE"

SECTION SHOWING LAYOUT OF ONE LAYER OF 30MM INERT ROUNDS IN BETWEEN THE TWO "SOND TUBES."  
NOTE: 15 LAYERS ARE REQUIRED.

THE DRAWING DEPICTS THE ITEMS AS TESTED AND ARE NOT TO BE USED FOR PRODUCTION PURPOSES. THE U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL (USADACS) AND THE U.S. GOVERNMENT ASSUME NO LIABILITY.

PART NO ACV00282-3

|   |     |  |  |                 |  |
|---|-----|--|--|-----------------|--|
| UNLESS OTHERWISE NOTED DIMENSIONS ARE IN INCHES. BREAK SHARP CORNERS AND EDGES. |     | DATE   | 96-01-17   | DESIGN ACTIVITY | U.S. ARMY<br>INDUSTRIAL OPERATIONS COMMAND<br>DEFENSE AMMUNITION CENTER AND SCHOOL<br>SAVANNA, ILLINOIS 61074-9639 |
| OPTIM   | SKK | CHECKER  | WM   | PROV ENG        | W. MEYER   |
| SUB-GRY   | WRM | JHK  | THOMAS J. MICHELS<br>CHIEF, SUPPLY ENGINEERING DIV |                 |  |
| SUBMITTED   |     | WILLIAM F. ERNST<br>CHIEF, LOGISTICS ENGINEERING OFFICE<br>DEFENSE AMMUNITION CENTER AND SCHOOL<br>GENERAL, U.S. ARMY MATERIEL COMMAND (AMC) |  |                 |  |
| MATERIAL  |     | GARY W. ABRISZ<br>U.S. ARMY<br>DEFENSE AMMUNITION CENTER AND SCHOOL  |  |                 |  |
| NEXT ASSY   |     | USED ON  |  | APPLICATION     |  |
| TEST CONTAINER  |     | 30MM INERT DEPLETED URANIUM ROUNDS   |  | SIZE            |  |
| CAGE CODE   |     | C 28620  |  | ACV00282        |  |
| SCALE   |     | NONE   |  | UNIT            |  |
| SHEET   |     | 3  |  | OF 8            |  |

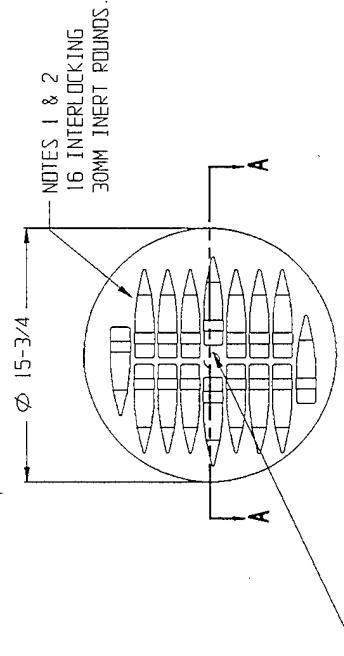
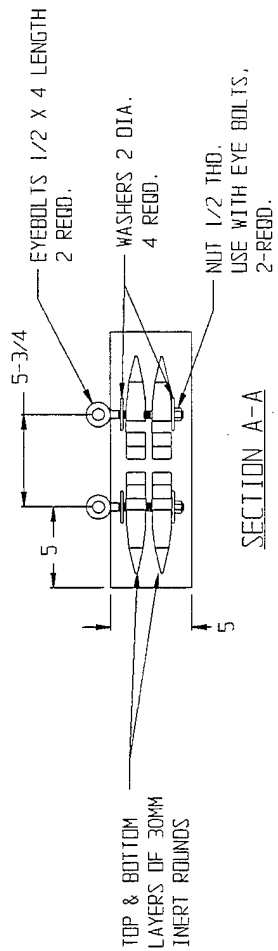
DISTRIBUTION STATEMENT.

NOT APPROVED FOR PUBLIC RELEASE;  
PROPRIETARY DRAWING.  
DO NOT DISTRIBUTE.

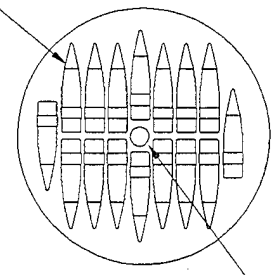
| REVISION |                        |          |             |
|----------|------------------------|----------|-------------|
| LTP      | DESCRIPTION            | DATE     | APPROVED    |
| -        | PRODUCT BASELINE       | 96-05-06 | W. R. MEYER |
| A        | ADMINISTRATIVE CHANGES | 96-05-20 |             |

NOTES:

1. TWO LAYERS OF 30MM INERT ROUNDS SUSPENDED IN CONCRETE; BOTTOM LAYER CONSISTING OF 16 INTERLOCKING 30MM INERT ROUNDS ON A FOUNDATION OF 1 INCH CONCRETE AS SHOWN, THEN PLACE 1 INCH OF CONCRETE AND 16 MORE INTERLOCKING 30MM INERT ROUNDS FOR TOP LAYER.
2. FOR CONCRETE MIX SPECIFICATIONS SEE SHEET 8.
3. RADIATION INSPECTION TUBE REQUIRED FOR TEST DRUM ONLY.
4. FOR 30MM INERT ROUND SPECIFICATION SEE SHEET 6.



NOTE 3  
LOCATION OF RADIATION  
INSPECTION TUBE (OMITTED  
TO SHOW 30MM INERT ROUND  
ARRANGEMENT).



TOP LAYER  
ARRANGEMENT

BOTTOM LAYER  
ARRANGEMENT

THE DRAWING DEPICTS THE ITEMS AS TESTED AND ARE NOT TO BE USED FOR PRODUCTION PURPOSES. THE U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL (USADACS) AND THE U.S. GOVERNMENT ASSUME NO LIABILITY.

PART NO ACV00282-4

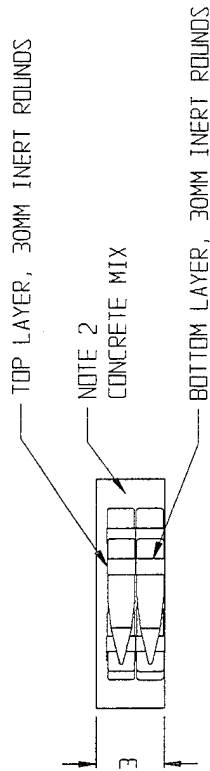
|  |  |   |   |
|--|--|---|---|
| UNLESS OTHERWISE NOTED<br>DIMENSIONS ARE IN INCHES.<br>BREAK<br>SHARP CORNERS AND EDGES. |  | DATE<br>96-01-17  | DESIGN ACTIVITY<br>U.S. ARMY<br>INDUSTRIAL DEFENSE COMMAND<br>DEFENSE AMMUNITION CENTER AND SCHOOL<br>SAVANNAH, ILLINOIS 61074-9638 |
| TOLERANCES ON<br>FRACTIONS<br>DECIMALS   |  | CHECKER<br>SKK WM W. MEYER                              |   |
| MATERIAL   |  | APPROVED<br>W. R. MEYER                                 |   |
| NEXT ASSY USED ON  |  | TEST CONTAINER<br>30MM INERT DEPLETED<br>URANIUM ROUNDS |   |
| APPLICATION  |  | SIZE<br>C 28620   | CAGE CODE<br>ACV00282   |
|  |  | SCALE<br>NONE   | UNIT<br>WT  |
|  |  | SHEET 4 OF 8  |   |

DISTRIBUTION STATEMENT

NOT APPROVED FOR PUBLIC RELEASE;  
PROPRIETARY DRAWING.  
DO NOT DISTRIBUTE.

| REVISION |                        |          |             |
|----------|------------------------|----------|-------------|
| LTR      | DESCRIPTION            | DATE     | APPROVED    |
| -        | PRODUCT BASELINE       | 96-05-06 | W. R. MEYER |
| A        | ADMINISTRATIVE CHANGES | 96-05-20 |             |

2. FOR CONCRETE MIX SPECIFICATION  
SEE DRAWING SHEET 8.



NOTE 1  
(13) 30MM INERT  
ROUNDS.

10

A

A

BOTTOM LAYER

PART NO ACV00282-5

NOT APPROVED FOR PUBLIC RELEASE;  
PROPRIETARY DRAWING.  
DO NOT DISTRIBUTE.

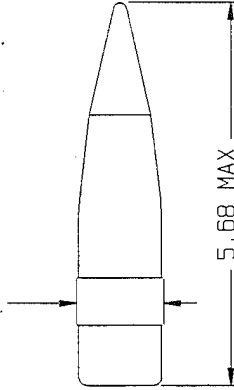
[illegible]



NOTES:

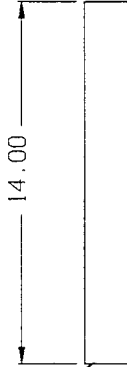
1. PROJECTILE ROUNDS-USED IN TEST CONTAINER WERE 3.008 INCH LENGTH. ACTUAL 30MM INERT DEPLETED URANIUM ROUNDS ARE 5.68 INCH. PGM-14 30MM AMMO.
2. RADIATION INSPECTION TUBE 1 INCH NOM SCH. 40 STEEL PIPE WELD ONE SIDE CLOSED

1.238 DIA. MAX



30MM INERT PROJECTILE

NOTE 2



RADIATION INSPECTION TUBE



THE DRAWING DEPICTS THE ITEMS AS TESTED AND ARE NOT TO BE USED FOR PRODUCTION PURPOSES. THE U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL (USADACS) AND THE U.S. GOVERNMENT ASSUME NO LIABILITY.

PART NO ACV00282-6

DISTRIBUTION STATEMENT.

NOT APPROVED FOR PUBLIC RELEASE;  
PROPRIETARY DRAWING.  
DO NOT DISTRIBUTE.

| REVISION |                        |             |
|----------|------------------------|-------------|
| LTR      | DESCRIPTION            | DATE        |
| -        | PRODUCT BASELINE       | 96-05-06    |
| A        | ADMINISTRATIVE CHANGES | 96-05-20    |
|          |                        | APPROVED    |
|          |                        | W. R. MEYER |

|   |                   |   |                     |                 |  |
|---|-------------------|---|---------------------|-----------------|--|
| UNLESS OTHERWISE NOTED<br>DIMENSIONS ARE IN INCHES. BREAK<br>SHARP CORNERS AND EDGES. |                   | DATE                                    | 96-01-22            | DESIGN ACTIVITY | U.S. ARMY<br>INDUSTRIAL OPERATIONS COMMAND<br>DEFENSE AMMUNITION CENTER AND SCHOOL<br>SAVANNA, ILLINOIS 61074-0839 |
| OPTION  | CHECKER           | PROJ ENGR                               |                     |                 |  |
| SKK   | WM                | W. MEYER                                |                     |                 |  |
| SUBMITTER   | THOMAS J. MICHELS | CHIEF, SUPPLY ENGINEERING DIV           |                     |                 |  |
| REVIEWER  | WILLIAM F. ERNST  | CHIEF, LOGISTICS ENGINEERING OFFICE     |                     |                 |  |
| APPROVED  | GARY W. ABRISZ    | CHIEF, U.S. ARMY MATERIAL COMMAND (AMC) |                     |                 |  |
| MATERIAL  |                   |   | TEST CONTAINER      |                 |  |
|   |                   |   | 30MM INERT DEPLETED |                 |  |
|   |                   |   | URANIUM ROUNDS      |                 |  |
| NEXT ASSY   |                   |   | SIZE                | CAGE CODE       |  |
| USED ON   |                   |   | C                   | 28620           | ACV00282   |
| APPLICATION   |                   |   | SCALE               | NONE            | UNIT WT  |
|   |                   |   | SHEET 6 OF 8        |                 |  |

# MATERIALS LIST

(FOR ONE 55 GALLON DEPLETED URANIUM SHIELDED CONTAINER)

(1) 55 GALLON DRUM - UN SPEC. A2/Y1.5/150/91  
STEEL, BLACK

NOTE: DRUM TO INCLUDE BARREL RETAINING RING,  
BARREL LID AND RUBBER GASKET.

Supplier: Skolnick Industries, Inc.

PDC Dean Ricker

4900 S. Kilbourn Ave.

Chicago, IL 60632-4593

312-735-0700

or other supplier

(130) LBS. PORTLAND CEMENT - TYPE ONE, manufactured  
by Essroc, 94 Lbs. bags.

Supplier: Handy Andy Hardware Store or Other Supplier.

(345) LBS. FINE HAMATITE AGGREGATE

Supplier: Nuclear Shielding Supplies and Service

Manjit Chopra

45656 S. Palo Verde, Suite 203

Tucson, AZ 85714

602-748-9362

(6) OZ. SUPER PLASTICIZER- DARACEN 100

Supplier: Mayer Material

RR 1 Bluff Rd.

Channahon, IL 60410

815-467-2236

or other supplier of DARACEN 100

(2) EYE BOLTS-1/2 x 4 THREAD LENGTH

Supplier: Handy Andy Hardware Store or Other Supplier

(2) NUTS - 1/2 Thread (for use with Eye Bolts)

Supplier: See Above

(4) WASHERS - 2 DIAMETER (for use with Eye Bolts)

Supplier: See Above

(283) 30MM INERT PROJECTILES

Supplier: U.S. ARMY

(52) LBS. Approx. WATER

(1) 10 DIA. "SOND TUBE"- 3/16 THICK FIBER FORM  
CUT TO 23 LENGTH.

OR EQUIVALENT CONCRETE FORM SUPPORT.

Supplier: McCann Construction Specialties Co.

303 Republic Ave.

Joliet, IL 60435-6519

815-744-5511

or other supplier

(1) 16 DIA. "SOND TUBE"- 1/4 THICK FIBER FORM  
CUT TO 28 LENGTH.

OR EQUIVALENT CONCRETE FORM SUPPORT.

Supplier: See Above

(143) LBS. SAND- coarse, all purpose, Torpedo brand,  
in 50 LBS. bags.

Supplier: Smith Brother Garden Center

2601 E. Lincoln Highway

New Lenox, IL 60451

815-485-9420

or other supplier

(260) LBS. COARSE AGGREGATE - 5/8 DIAMETER

Metanec stone (small)

Supplier: See Above or other supplier

THE DRAWING DEPICTS THE ITEMS AS TESTED AND ARE NOT TO BE USED FOR  
PRODUCTION PURPOSES. THE U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL  
(USADACS) AND THE U.S. GOVERNMENT ASSUME NO LIABILITY.

PART NO ACV00282-7

## DISTRIBUTION STATEMENT

NOT APPROVED FOR PUBLIC RELEASE;  
PROPRIETARY DRAWING.  
DO NOT DISTRIBUTE.

| REVISION |                        |          |             |
|----------|------------------------|----------|-------------|
| LTR      | DESCRIPTION            | DATE     | APPROVED    |
| -        | PRODUCT BASELINE       | 96-05-06 | M. R. MEYER |
| A        | ADMINISTRATIVE CHANGES | 96-05-20 |             |

|   |                   |   |                                      |              |  |          |   |            |                   |  |                  |             |                |   |                |                     |                |
|---|-------------------|---|--------------------------------------|--------------|--|----------|---|------------|-------------------|--|------------------|-------------|----------------|---|----------------|---------------------|----------------|
| UNLESS OTHERWISE NOTED<br>DIMENSIONS ARE IN INCHES.<br>SHARP CORNERS AND EDGES.   | DATE<br>96-01-17  | DESIGN ACTIVITY<br>U.S. ARMY<br>INDUSTRIAL OPERATIONS COMMAND<br>DEFENSE AMMUNITION CENTER AND SCHOOL<br>SAVANNA, ILLINOIS 61074-9639 |                                      |              |  |          |   |            |                   |  |                  |             |                |   |                |                     |                |
| <table border="1"> <tr> <td>OPTION</td> <td>CHECKER</td> <td>PROJ. ENGR</td> </tr> <tr> <td>SKK</td> <td>WM</td> <td>W. MEYER</td> </tr> </table> | OPTION            | CHECKER   | PROJ. ENGR                           | SKK          | WM   | W. MEYER | <table border="1"> <tr> <td>STUDY-ORDY</td> <td>THOMAS J. MICHELS</td> </tr> <tr> <td>SUBMITTER</td> <td>WILLIAM F. ERNST</td> </tr> <tr> <td>APPROVED BY</td> <td>GARY W. ABRISZ</td> </tr> </table> | STUDY-ORDY | THOMAS J. MICHELS | SUBMITTER  | WILLIAM F. ERNST | APPROVED BY | GARY W. ABRISZ | <table border="1"> <tr> <td>TEST CONTAINER</td> </tr> <tr> <td>30MM INERT DEPLETED</td> </tr> <tr> <td>URANIUM ROUNDS</td> </tr> </table> | TEST CONTAINER | 30MM INERT DEPLETED | URANIUM ROUNDS |
| OPTION  | CHECKER           | PROJ. ENGR  |                                      |              |  |          |   |            |                   |  |                  |             |                |   |                |                     |                |
| SKK   | WM                | W. MEYER  |                                      |              |  |          |   |            |                   |  |                  |             |                |   |                |                     |                |
| STUDY-ORDY  | THOMAS J. MICHELS |   |                                      |              |  |          |   |            |                   |  |                  |             |                |   |                |                     |                |
| SUBMITTER   | WILLIAM F. ERNST  |   |                                      |              |  |          |   |            |                   |  |                  |             |                |   |                |                     |                |
| APPROVED BY   | GARY W. ABRISZ    |   |                                      |              |  |          |   |            |                   |  |                  |             |                |   |                |                     |                |
| TEST CONTAINER  |                   |   |                                      |              |  |          |   |            |                   |  |                  |             |                |   |                |                     |                |
| 30MM INERT DEPLETED   |                   |   |                                      |              |  |          |   |            |                   |  |                  |             |                |   |                |                     |                |
| URANIUM ROUNDS  |                   |   |                                      |              |  |          |   |            |                   |  |                  |             |                |   |                |                     |                |
| <table border="1"> <tr> <td>FRACTIONS</td> <td>1/8</td> </tr> <tr> <td>DECIMALS</td> <td>1</td> </tr> </table>                                    | FRACTIONS         | 1/8   | DECIMALS                             | 1            | <table border="1"> <tr> <td>SIZE</td> <td>C</td> </tr> <tr> <td>CAGE CODE</td> <td>28620</td> </tr> </table> | SIZE     | C   | CAGE CODE  | 28620             | <table border="1"> <tr> <td>SCALE</td> <td>NONE</td> </tr> <tr> <td>UNIT</td> <td>WT</td> </tr> </table> | SCALE            | NONE        | UNIT           | WT  |                |                     |                |
| FRACTIONS   | 1/8               |   |                                      |              |  |          |   |            |                   |  |                  |             |                |   |                |                     |                |
| DECIMALS  | 1                 |   |                                      |              |  |          |   |            |                   |  |                  |             |                |   |                |                     |                |
| SIZE  | C                 |   |                                      |              |  |          |   |            |                   |  |                  |             |                |   |                |                     |                |
| CAGE CODE   | 28620             |   |                                      |              |  |          |   |            |                   |  |                  |             |                |   |                |                     |                |
| SCALE   | NONE              |   |                                      |              |  |          |   |            |                   |  |                  |             |                |   |                |                     |                |
| UNIT  | WT                |   |                                      |              |  |          |   |            |                   |  |                  |             |                |   |                |                     |                |
| <table border="1"> <tr> <td>DEFENSE AMMUNITION CENTER AND SCHOOL</td> <td>SHEET 7 OF 8</td> </tr> </table>  |                   |   | DEFENSE AMMUNITION CENTER AND SCHOOL | SHEET 7 OF 8 |  |          |   |            |                   |  |                  |             |                |   |                |                     |                |
| DEFENSE AMMUNITION CENTER AND SCHOOL  | SHEET 7 OF 8      |   |                                      |              |  |          |   |            |                   |  |                  |             |                |   |                |                     |                |

# CONCRETE MIXTURE

(FOR ONE BATCH OF HIGH DENSITY CONCRETE)

| REVISION |                        |          |
|----------|------------------------|----------|
| LTR      | DESCRIPTION            | DATE     |
| -        | PRODUCT BASELINE       | 95-05-05 |
| A        | ADMINISTRATIVE CHANGES | 95-05-20 |

| INGREDIENTS                      | WEIGHT   |
|----------------------------------|----------|
| PORTLAND CEMENT                  | 10 LBS   |
| WATER                            | 6 LBS    |
| COARSE AGGREGATE (5/8" DIAMETER) | 20 LBS   |
| SAND                             | 11 LBS   |
| FINE HEMATITE                    | 26.5 LBS |
| SUPER PLASTICIZER                | 0.5 OZ   |

THE BATCH CAN BE ANY SIZE, AS LONG AS THE INGREDIENTS ARE A MULTIPLE OF THE ABOVE.

THE DRAWING DEPICTS THE ITEMS AS TESTED AND ARE NOT TO BE USED FOR PRODUCTION PURPOSES. THE U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL (USADACS) AND THE U.S. GOVERNMENT ASSUME NO LIABILITY.

PART NO ACV00282-8

## DISTRIBUTION STATEMENT

NOT APPROVED FOR PUBLIC RELEASE;  
PROPRIETARY DRAWING.  
DO NOT DISTRIBUTE.

|  |  |   |  |   |  |  |  |
|--|--|---|--|---|--|--|--|
| DATE   |  | 96-01-19  |  | DESIGN ACTIVITY   |  | U.S. ARMY<br>INDUSTRIAL OPERATIONS COMMAND<br>DEFENSE AMMUNITION CENTER AND SCHOOL<br>SAVANNA, ILLINOIS 61074-9639 |  |
| UNLESS OTHERWISE NOTED,<br>DIMENSIONS ARE IN INCHES. BREAK<br>SHARP CORNERS AND EDGES. |  | DRAWN BY<br>SKK   |  | CHECKED BY<br>WM  |  | PROJECT ENGINEER<br>W. MEYER   |  |
| TOLERANCES ON<br>FRACTIONS<br>DECIMALS   |  | 1<br>1/8<br>1   |  | SUBMITTER<br>WRN/JHK                                    |  | THOMAS J. MICHELS<br>CHIEF, QUALITY ENGINEERING DIV.   |  |
| MATERIAL   |  | SUBMITTED BY<br>WILLIAM F. ERNST  |  | TEST CONTAINER<br>30MM INERT DEPLETED<br>URANIUM ROUNDS |  | SIZE<br>C  |  |
| NEXT ASSY  |  | USED ON   |  | SCALE   |  | UNIT   |  |
| APPLICATION  |  | GARY W. ABRISZ  |  | NONE  |  | WT   |  |
|  |  | APPROVED BY<br>GENERAL, U.S. ARMY<br>DEFENSE AMMUNITION CENTER AND SCHOOL |  | SHEET   |  | 8 OF 8   |  |

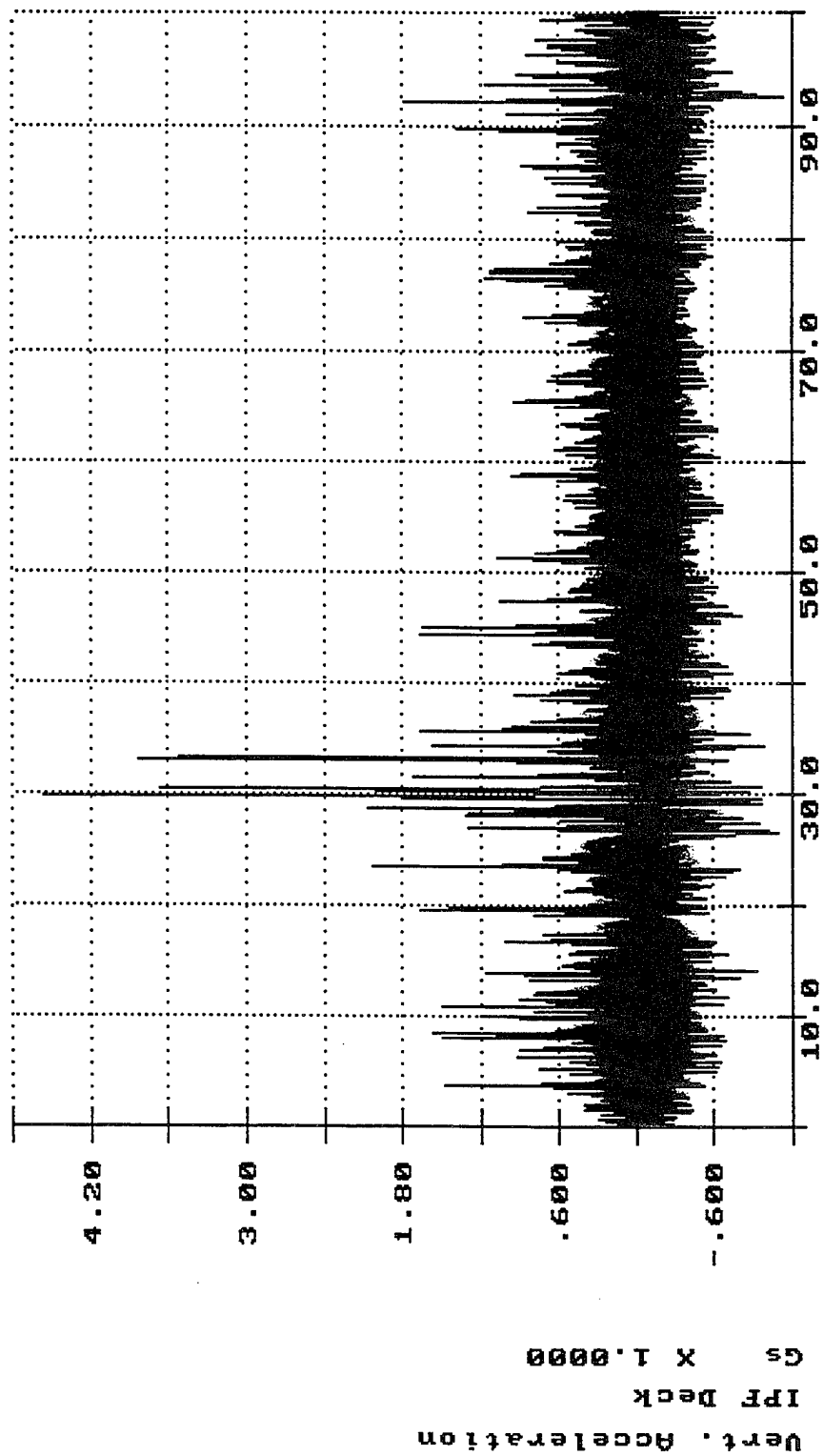
PART 7

GRAPHS

Vibration test of Nuc Drum

Aug 01 12:47:39 1995

7

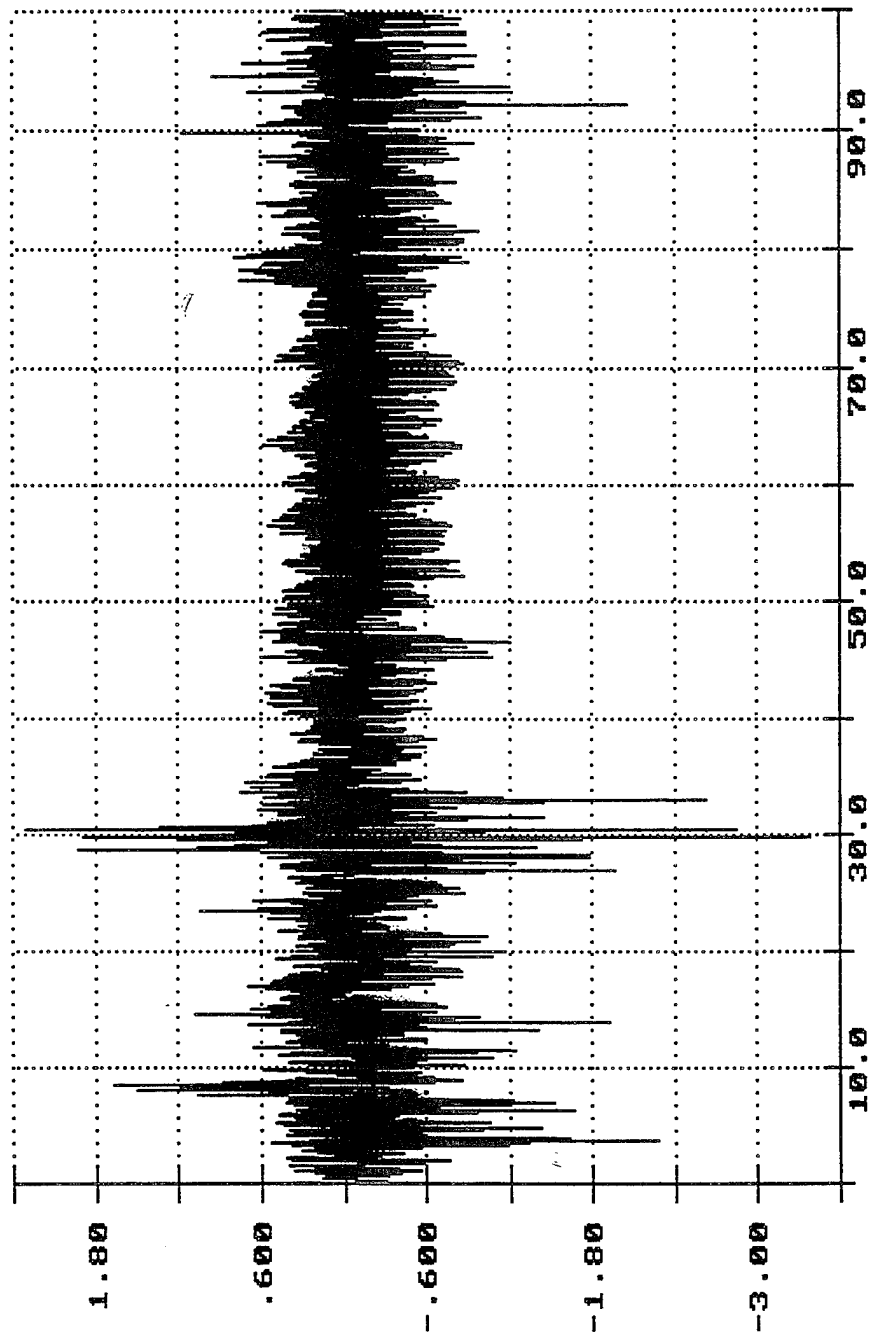


Time of Sample

Seconds X 1.0000

Vibration test of Nuc Drum

Aug 01 12:47:39 1995



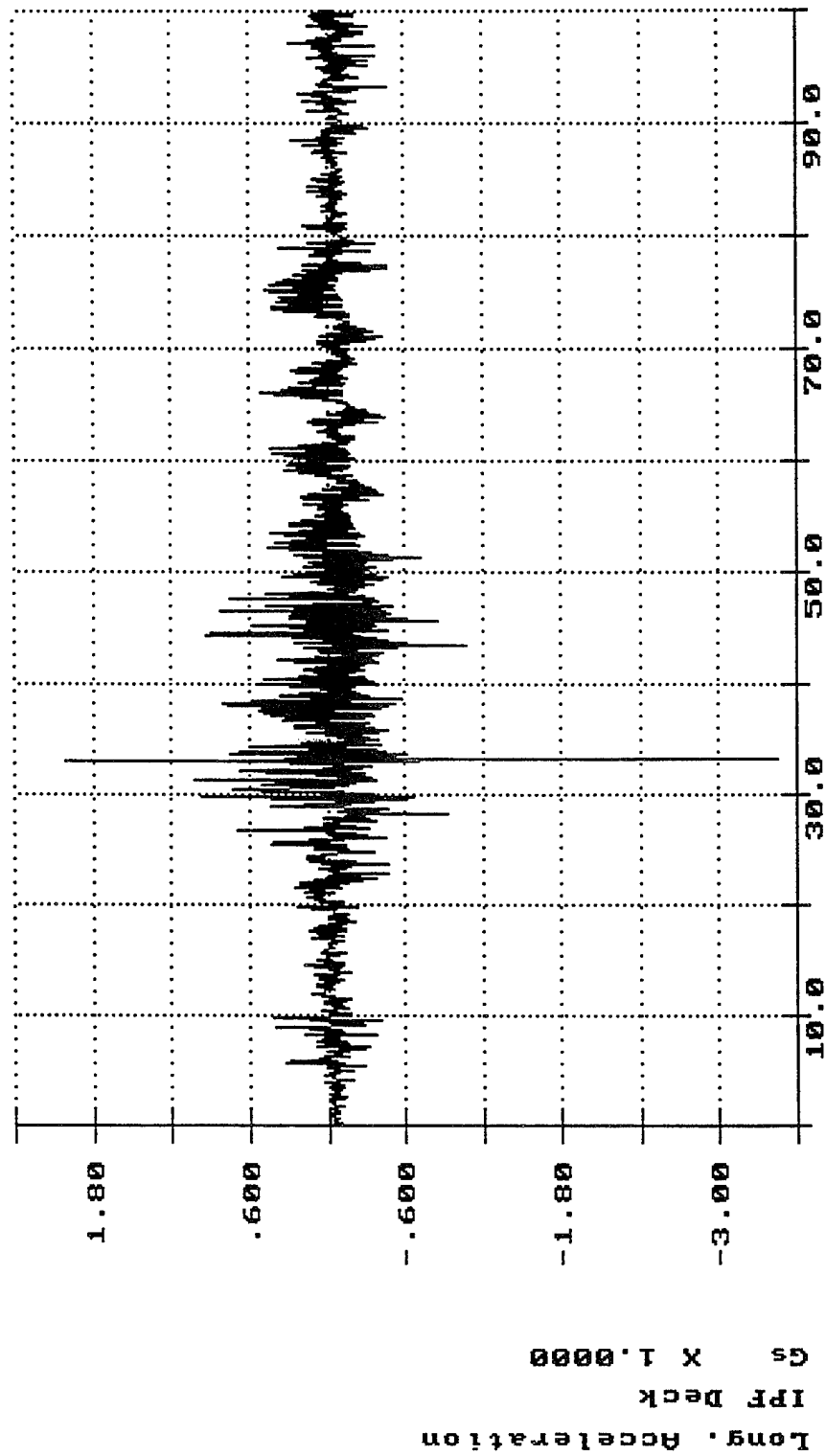
Time of Sample

Seconds X 1.0000

Vibration test of Nuc Drum

Aug 01 12:47:39 1995

7



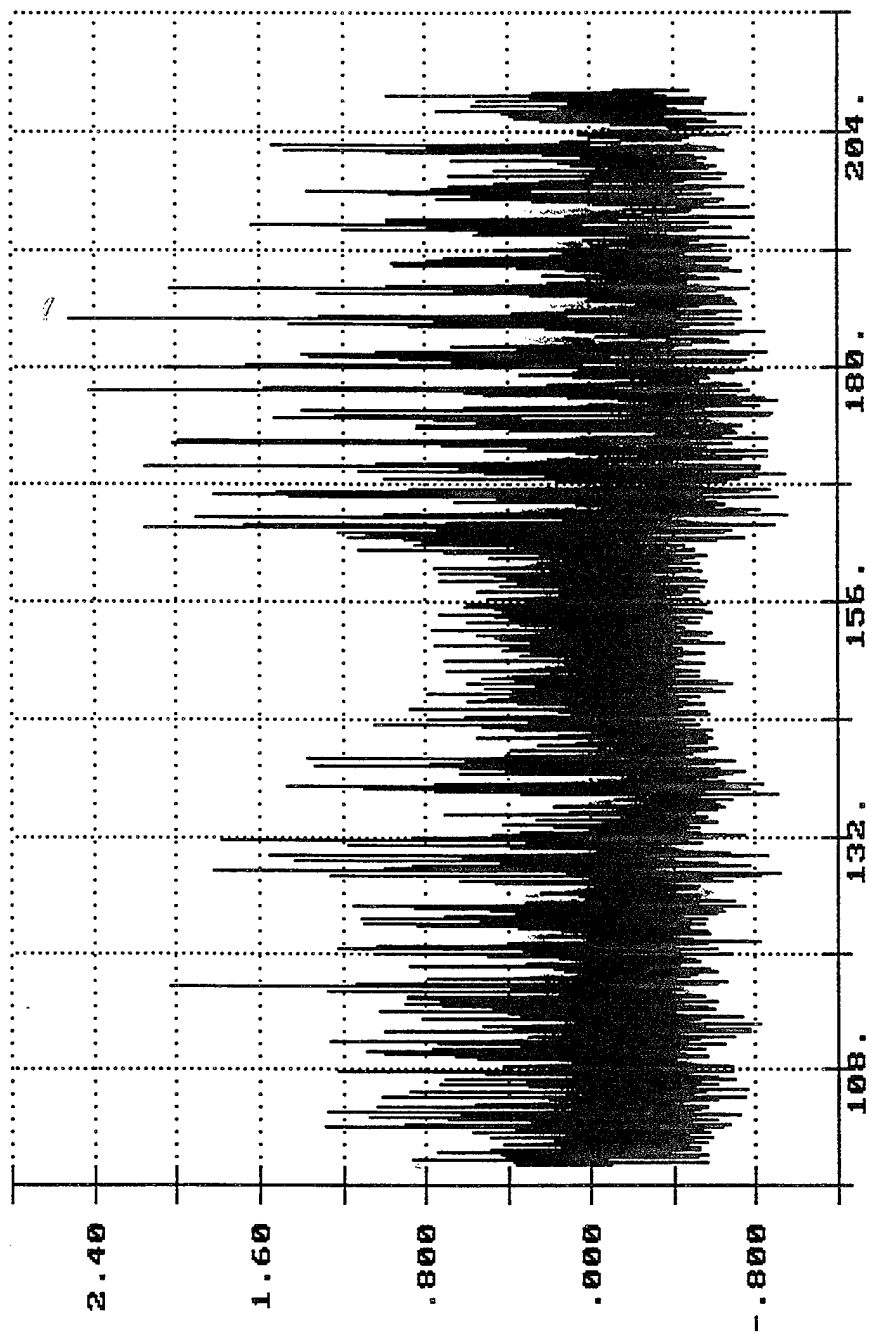
Time of Sample

Seconds X 1.0000

9

Vibration test of Nuc Drum

Aug 01 12:47:39 1995



Time of Sample

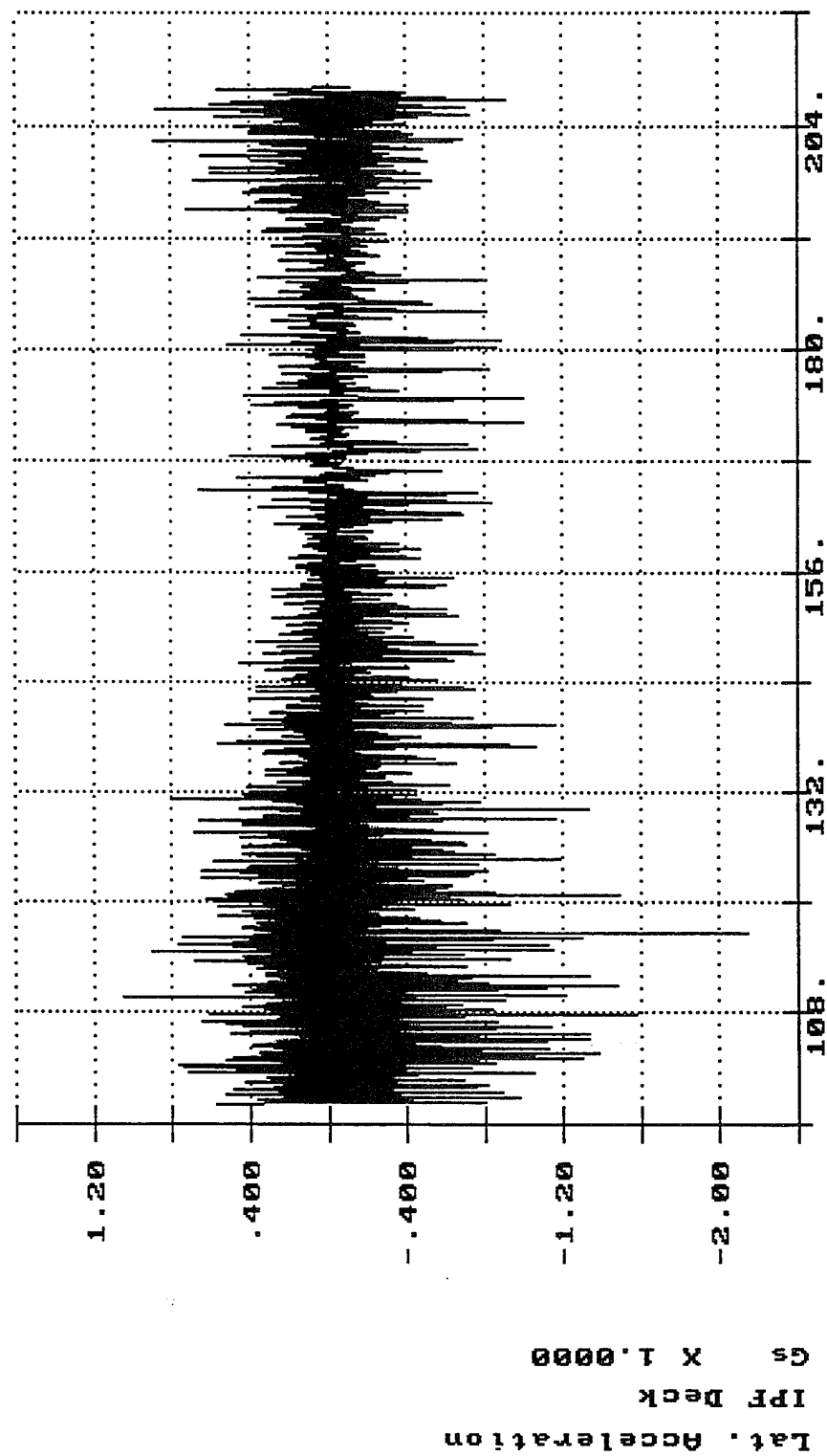
Seconds X 1.0000



Vibration test of Nuc Drum

Aug 01 12:47:39 1995

7

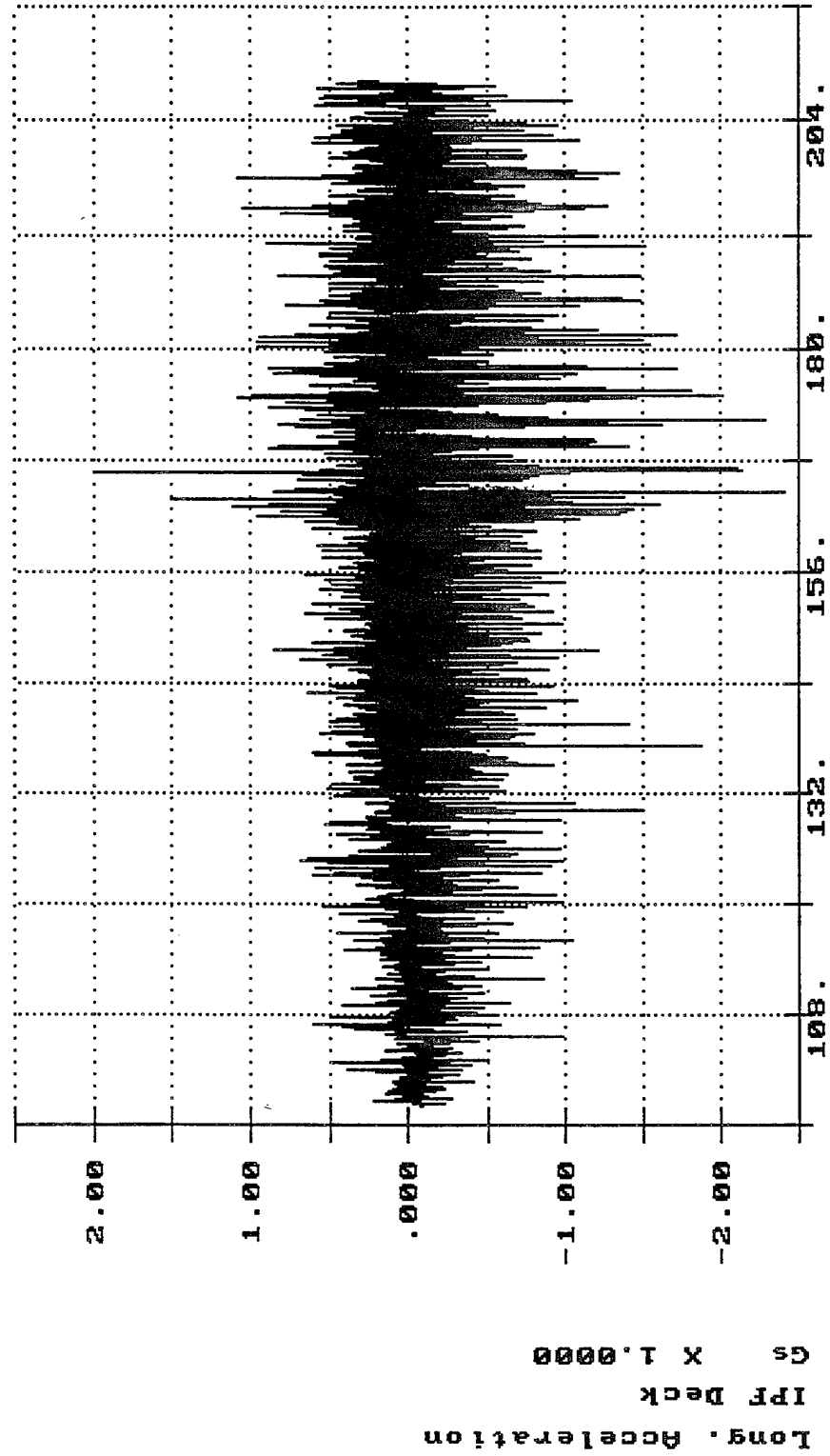


7

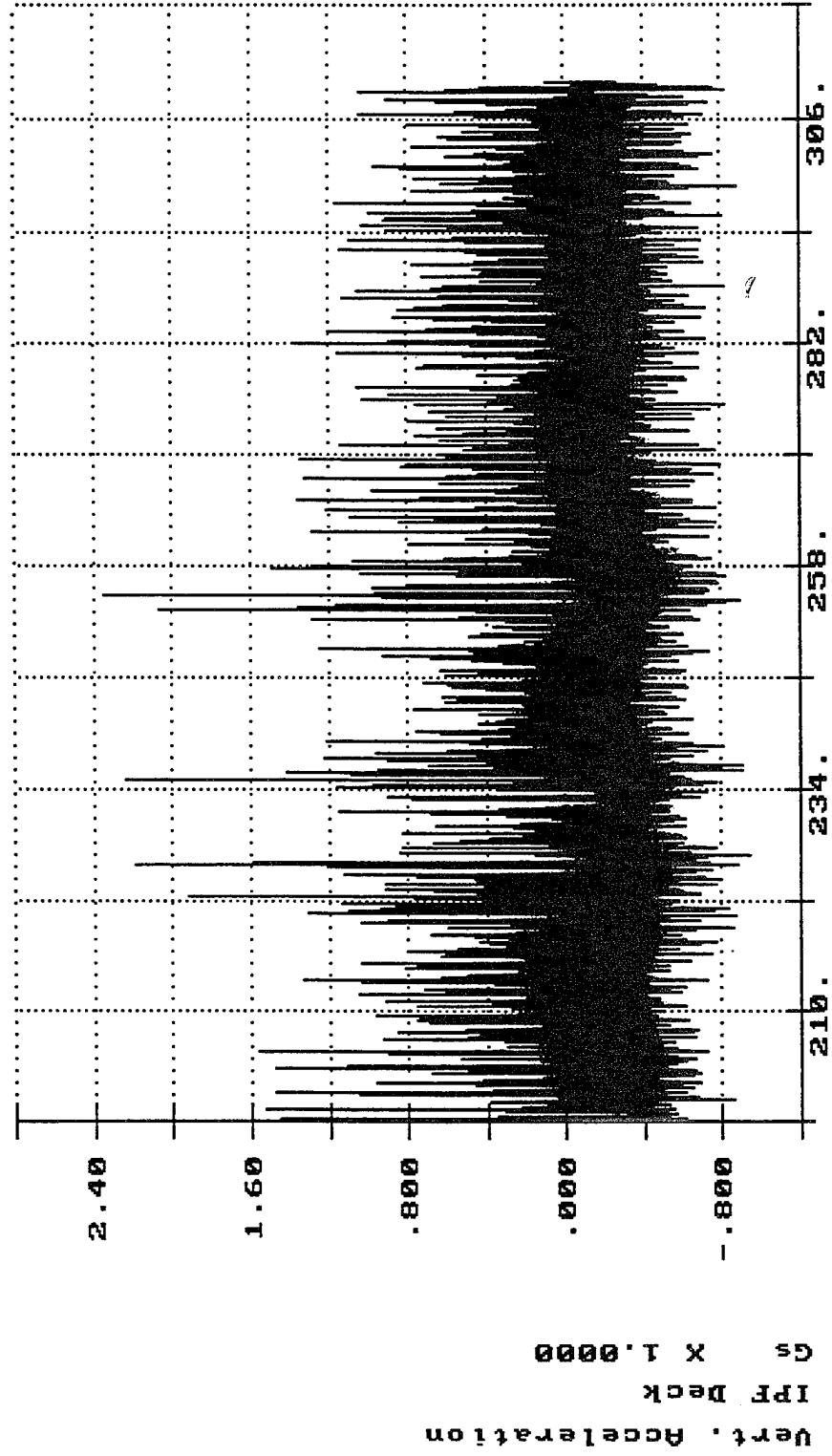
Vibration test of Nuc Drum

Aug 01 12:47:39 1995

7



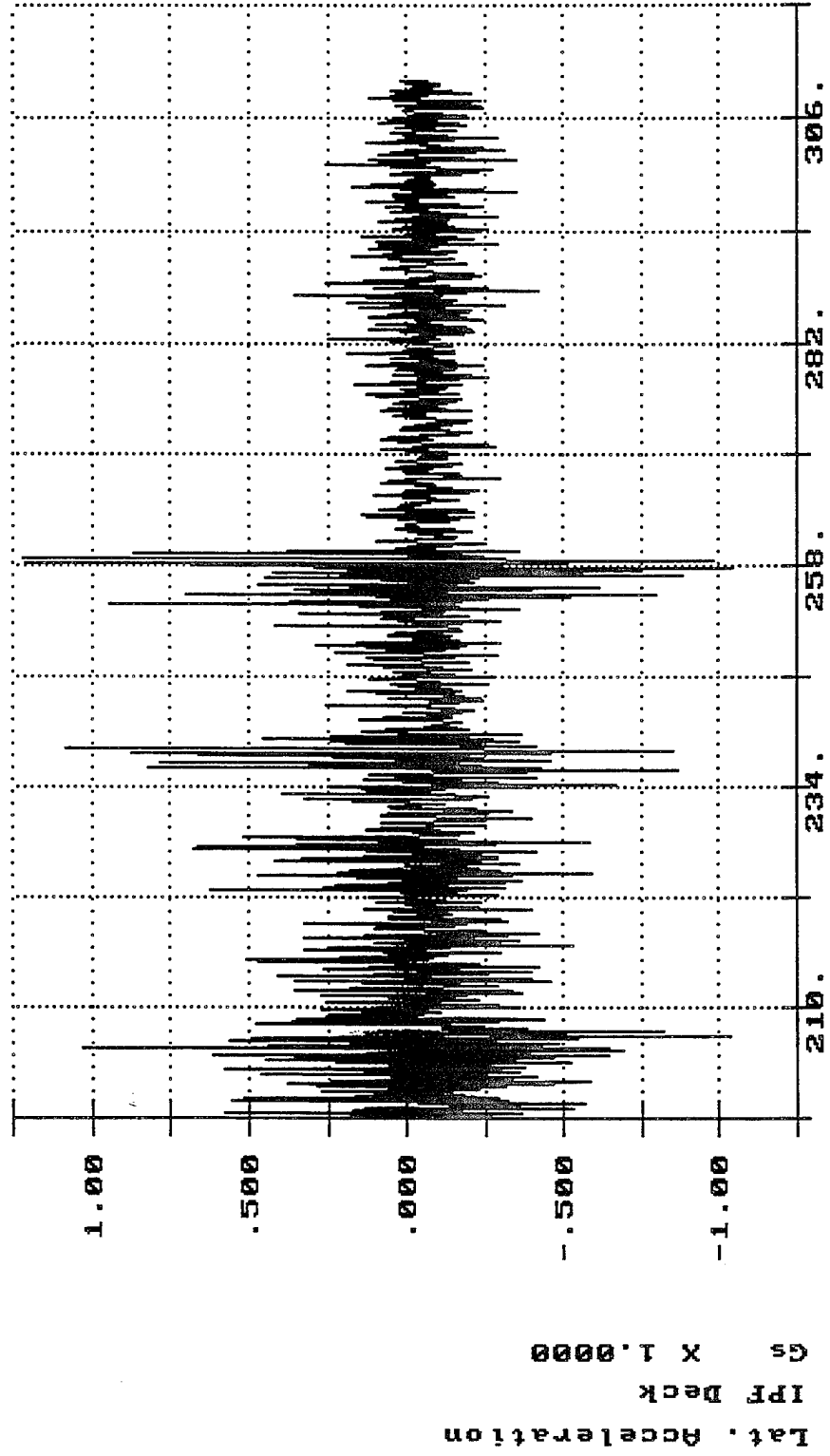
Vibration test of Nuc Drum Aug 01 12:47:39 1995



Time of Sample  
Seconds X 1.0000

Vibration test of Nuc Drum

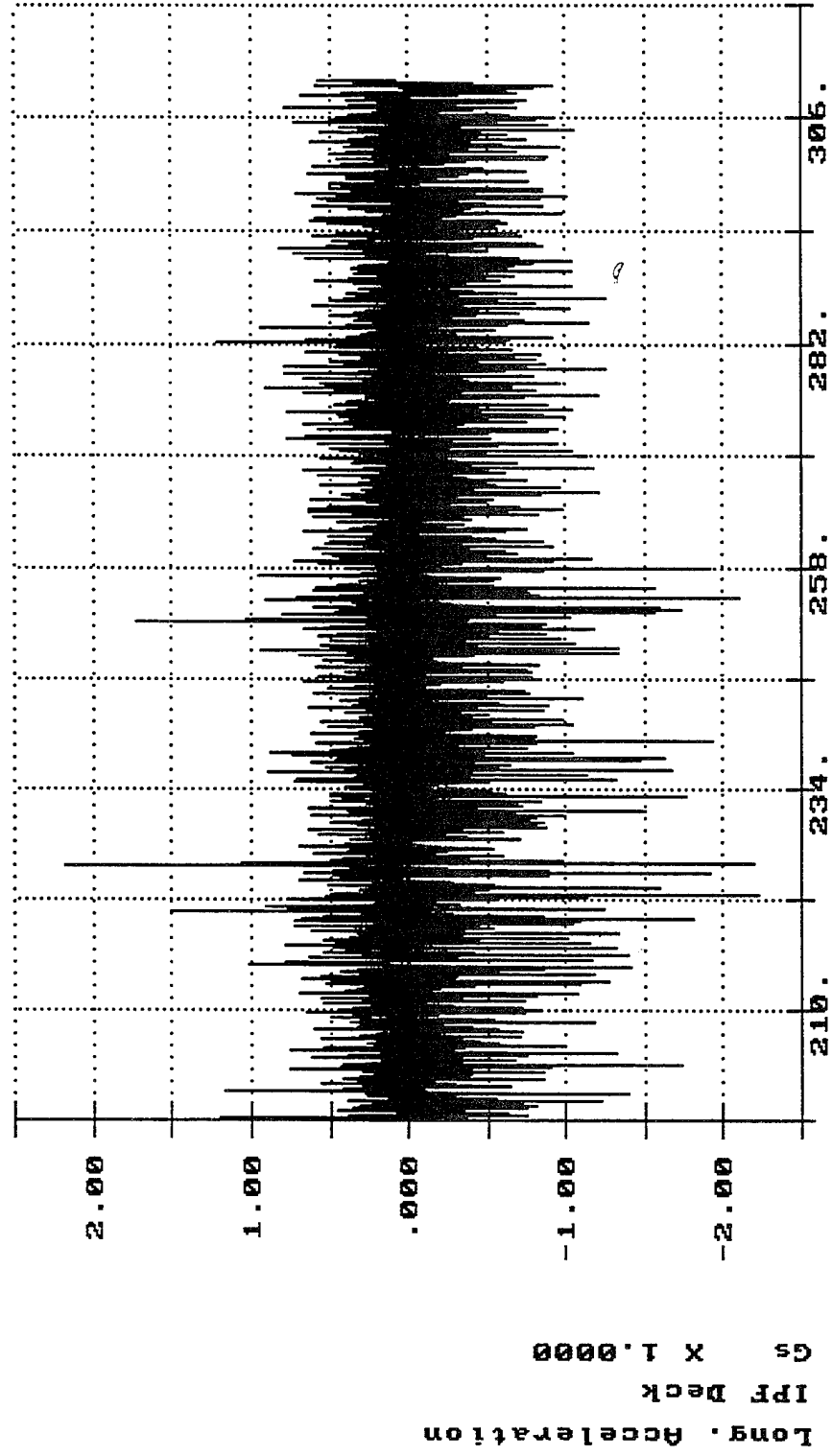
Aug 01 12:47:39 1995



Vibration test of Nuc Drum

Aug 01 12:47:39 1995

7

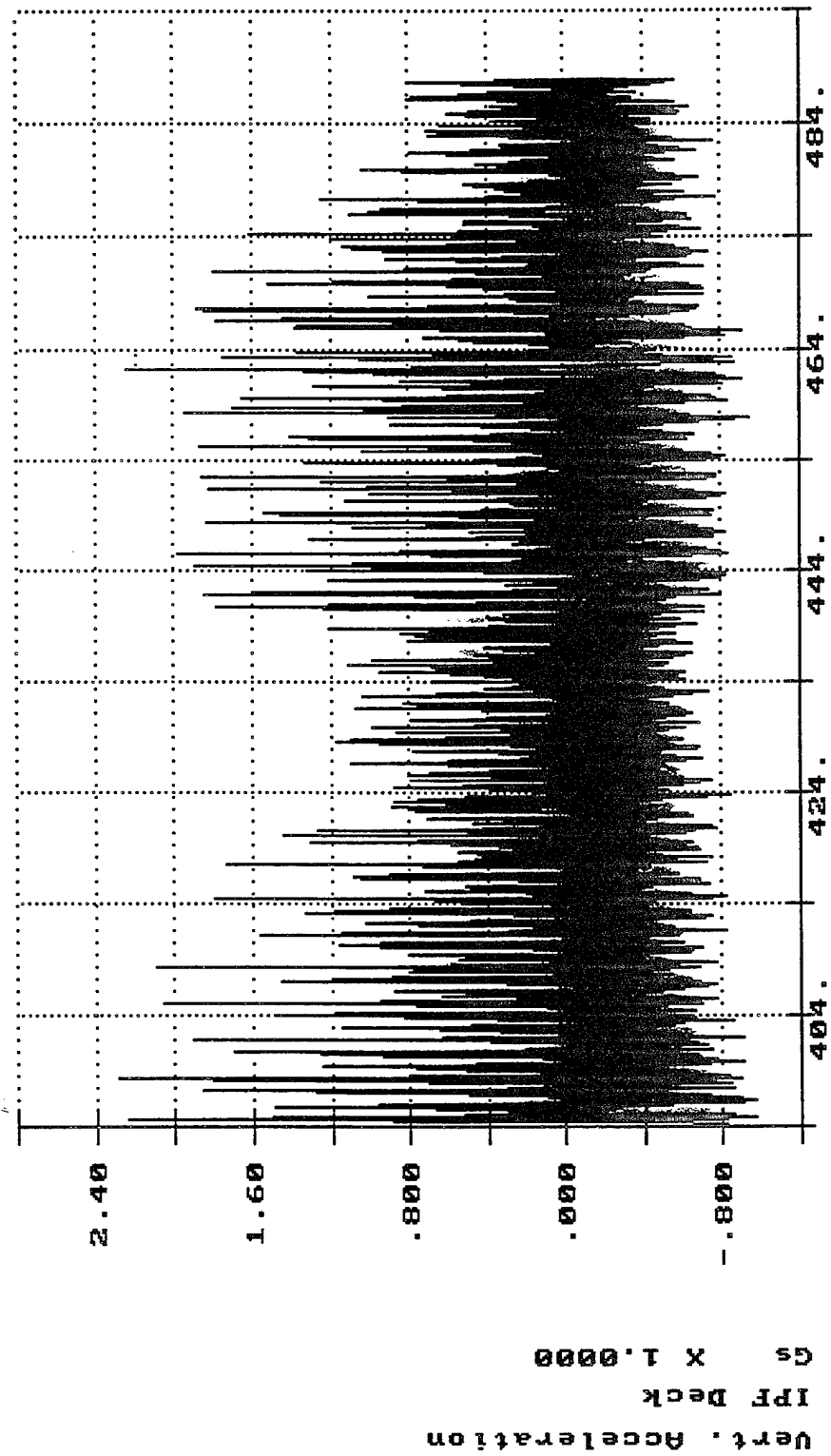


Time of Sample

Seconds X 1.0000

Vibration test of Nuc Drum

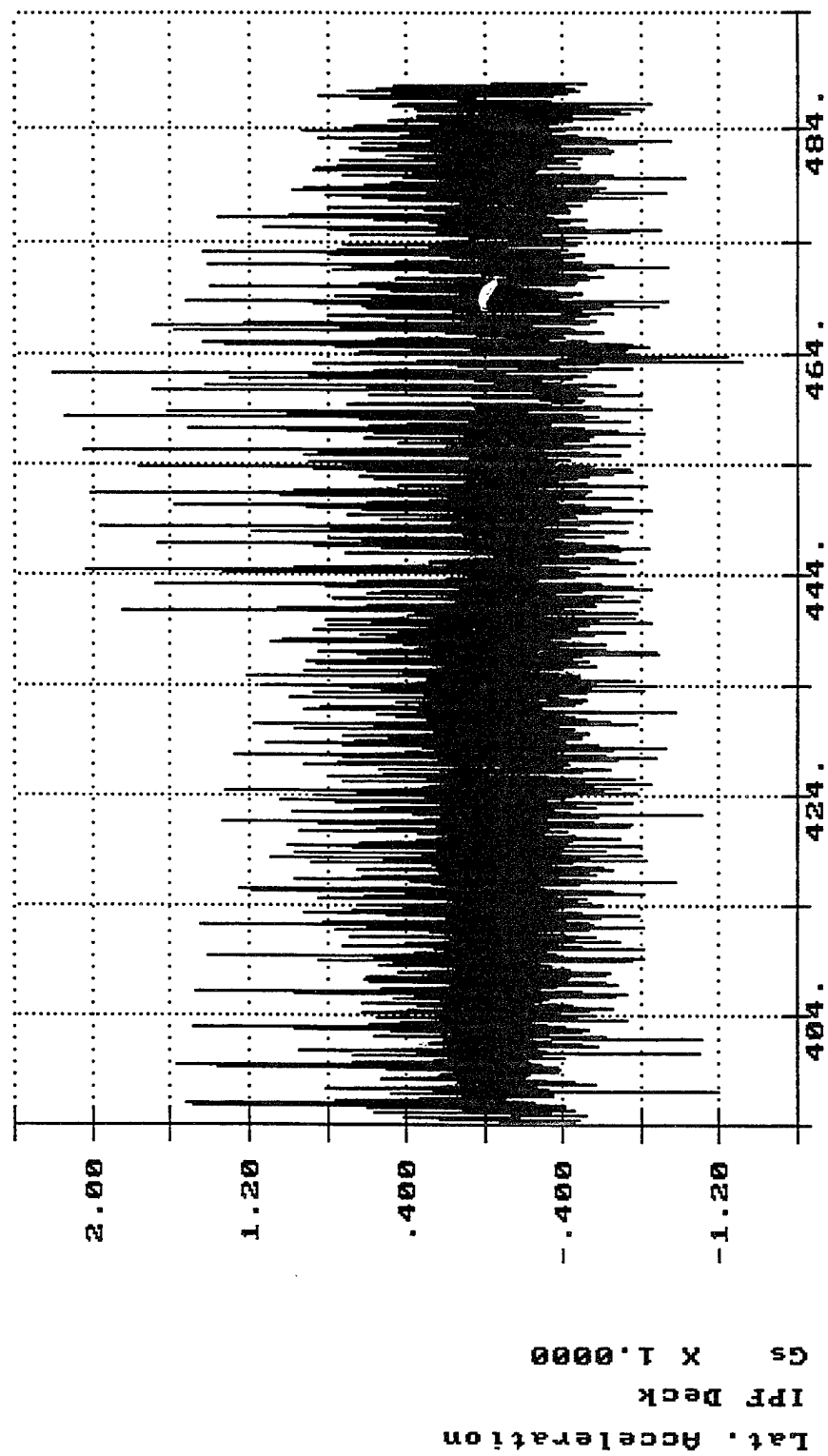
Aug 01 12:47:39 1995



Vibration test of Nuc Drum

Aug 01 12:47:39 1995

7



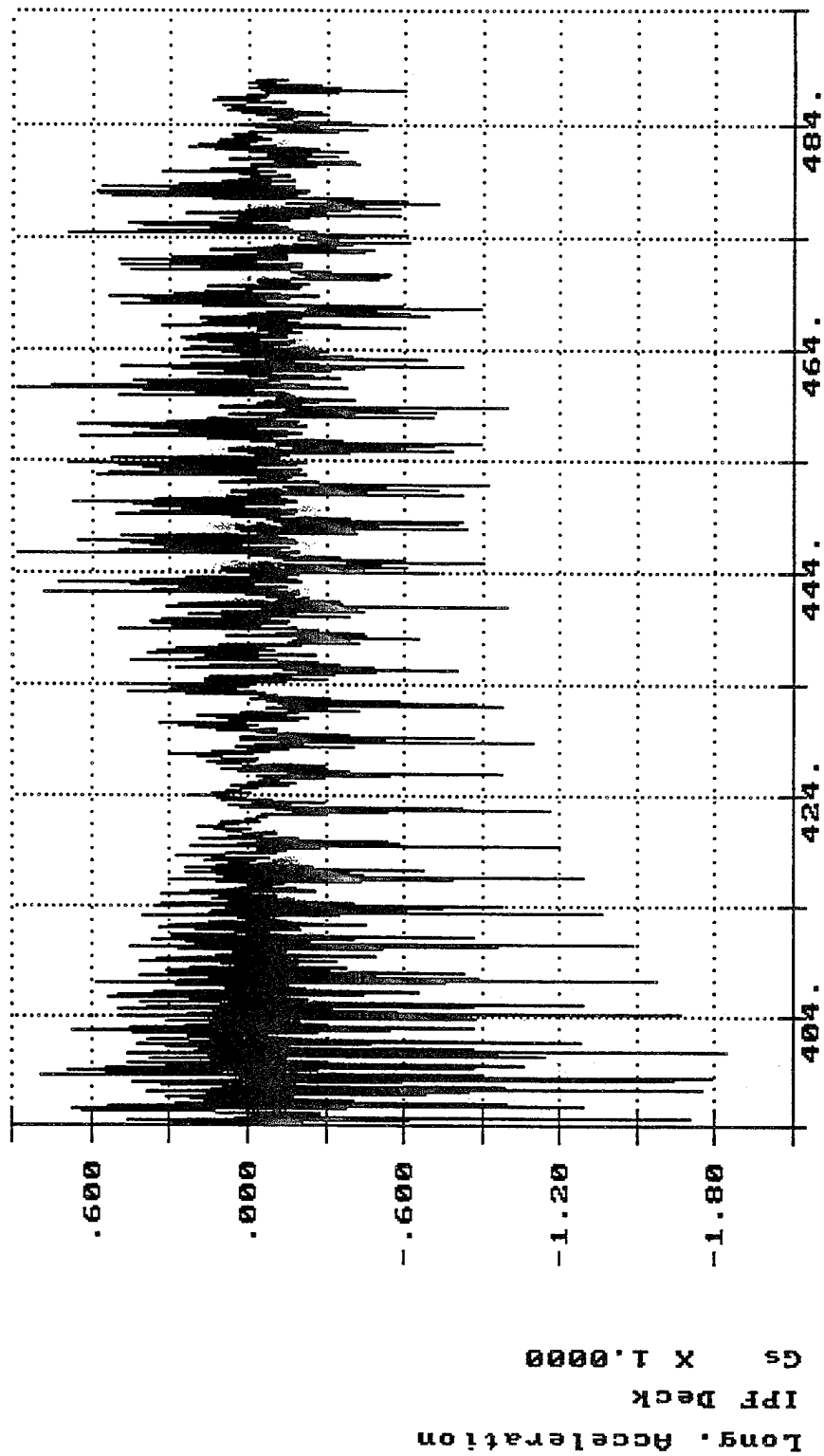
Time of Sample

Seconds X 1.0000



Vibration test of Nuc Drum

Aug 01 12:47:39 1995



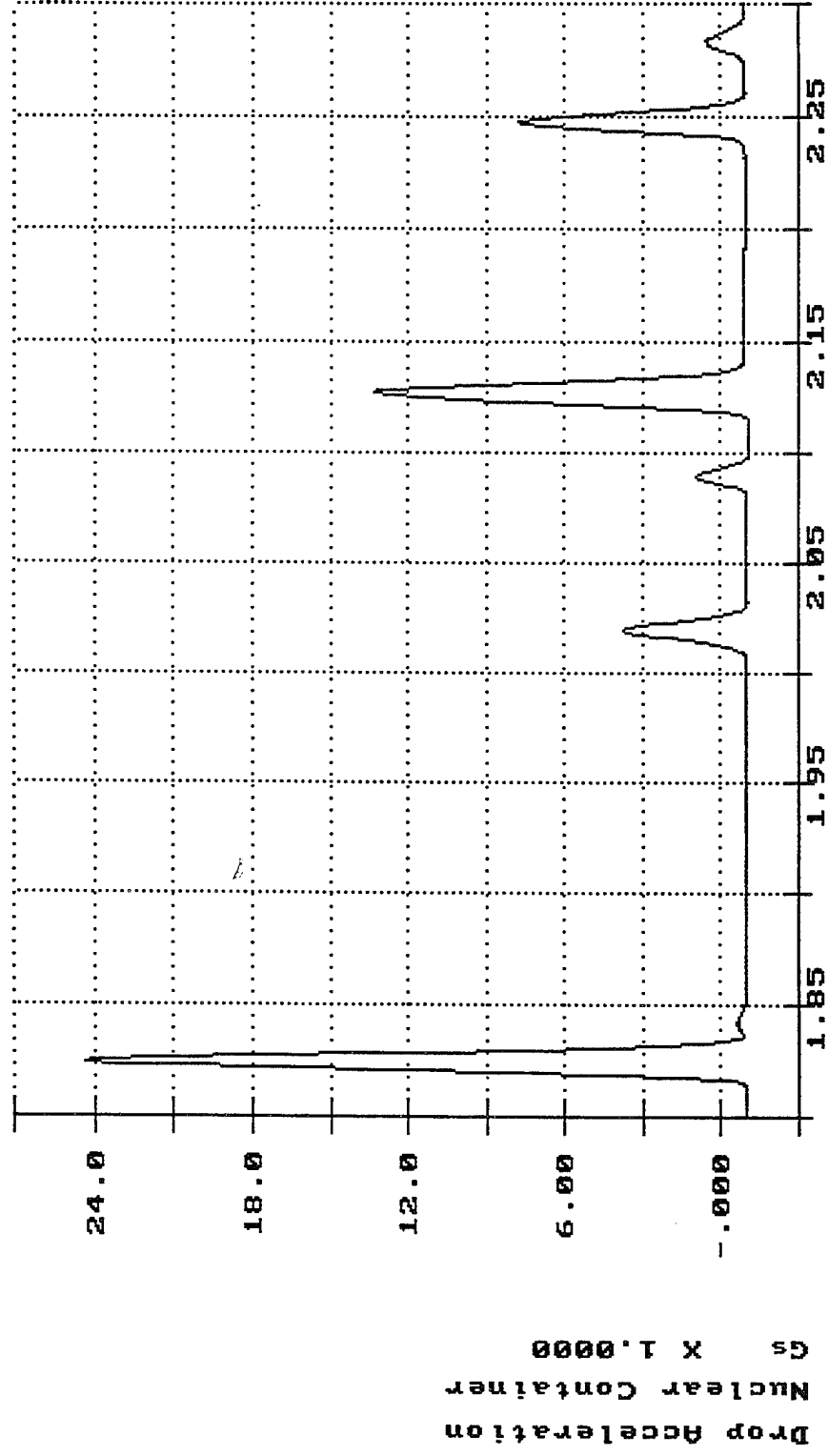
Time of Sample

Seconds X 1.0000

Side drop of Nuc Drum

Aug 02 13:14:25 1993

7

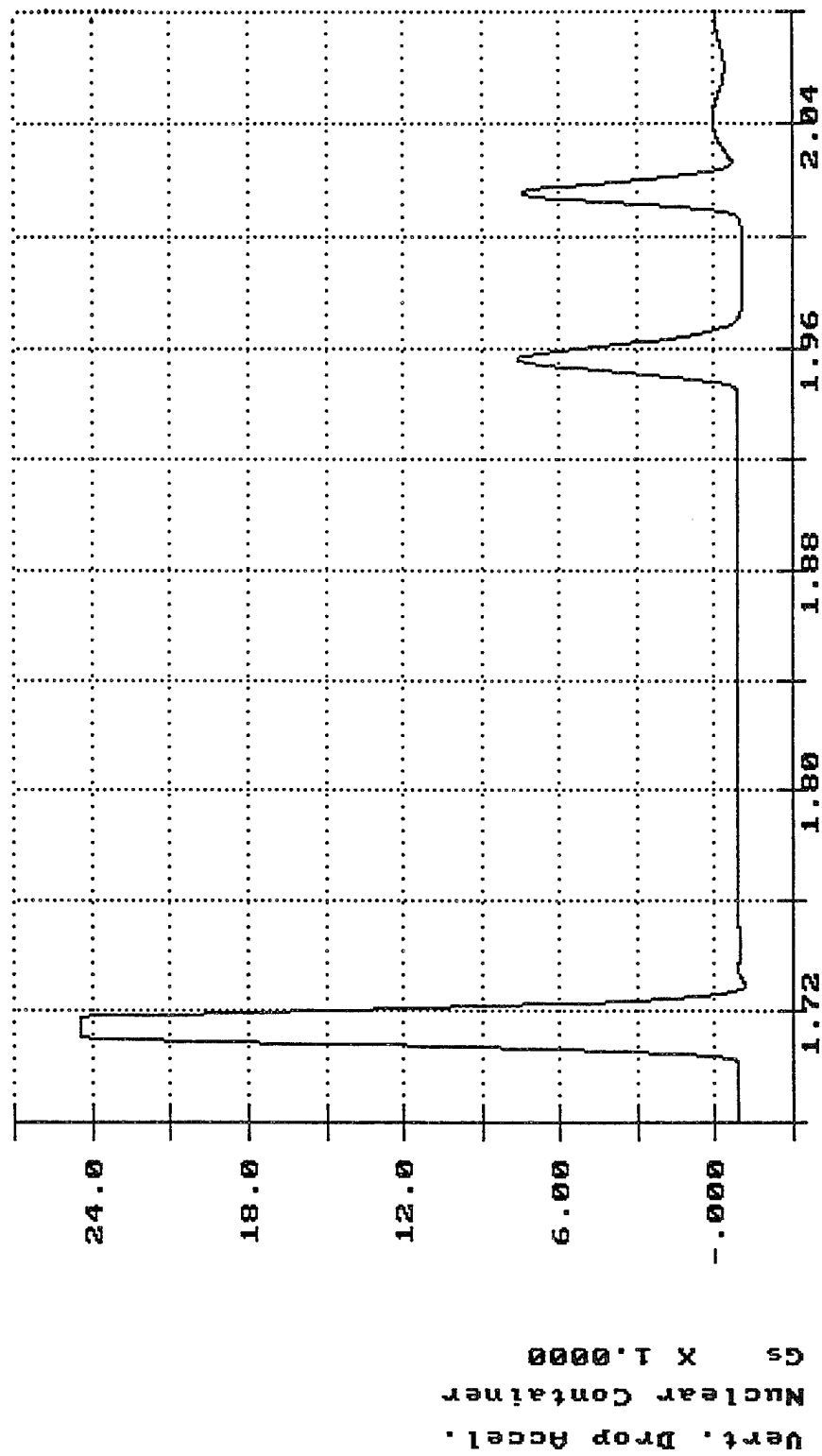


Time of Sample

Seconds X 1.0000

End drop of Nuc Drum

Aug 02 14:42:25 1995

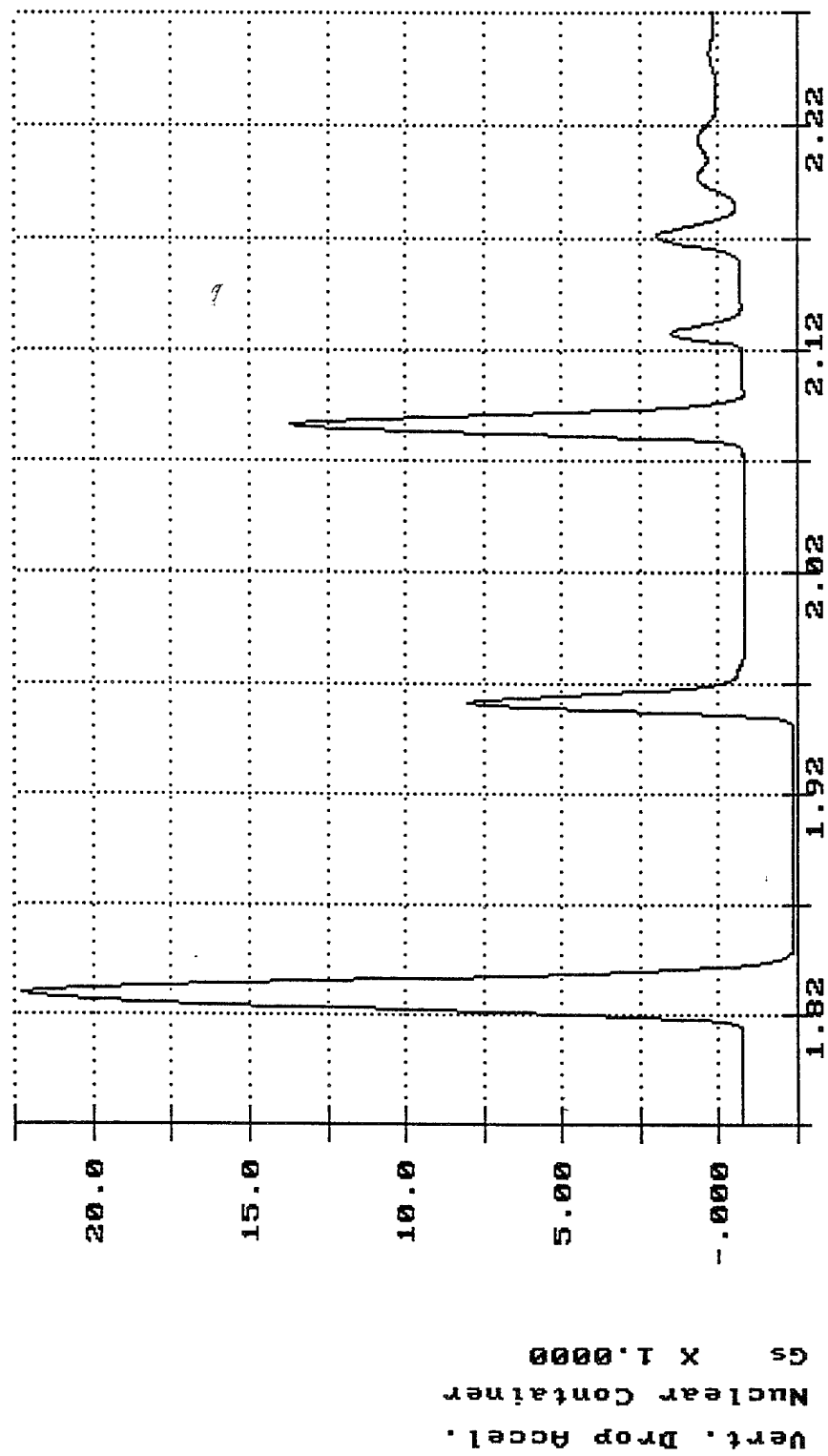


Time of Sample

Seconds X 1.0000

Angled drop of Nuc Drum

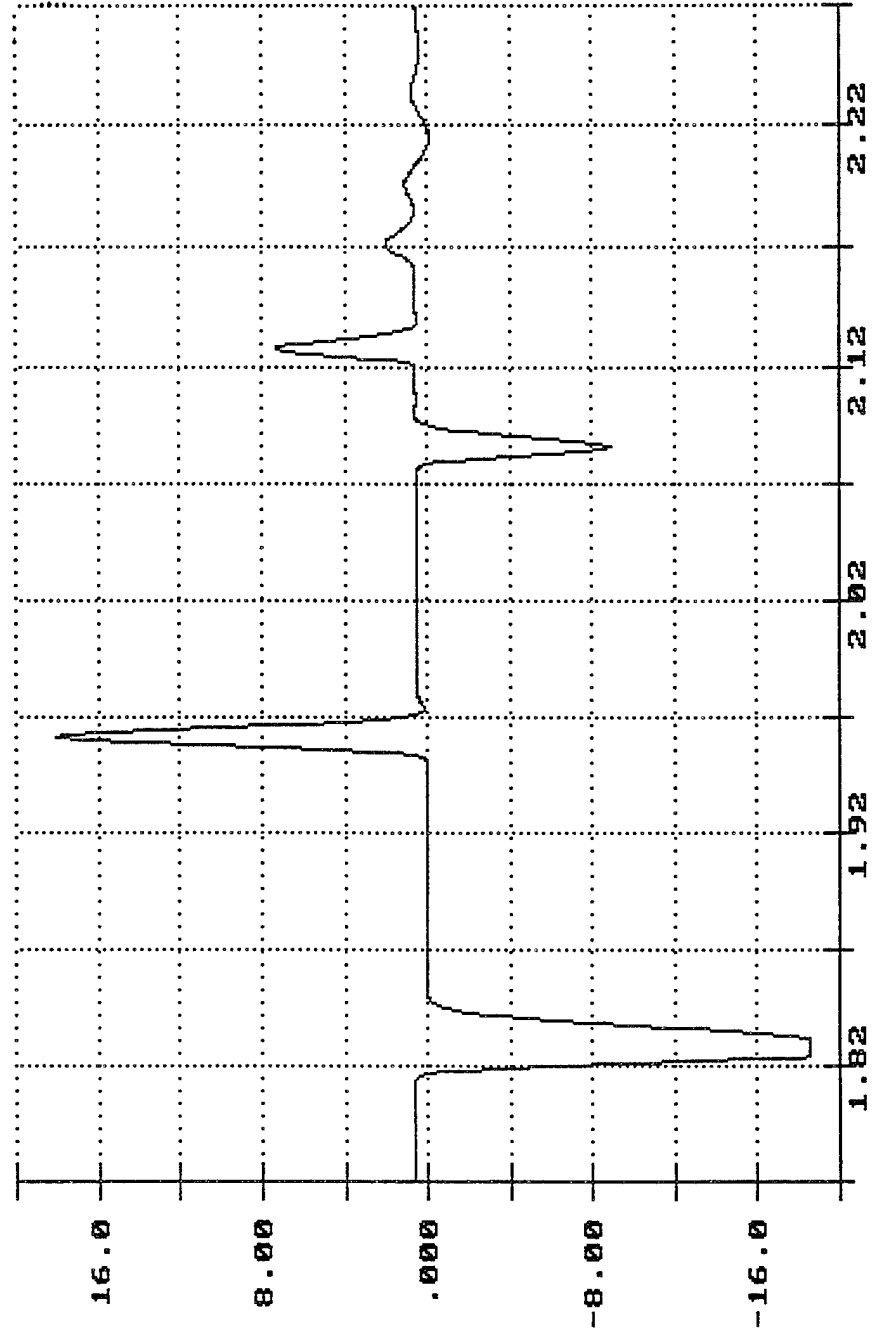
Aug 02 13:58:46 1995



Angled drop of Nuc Drum

Aug 02 13:58:46 1993

7

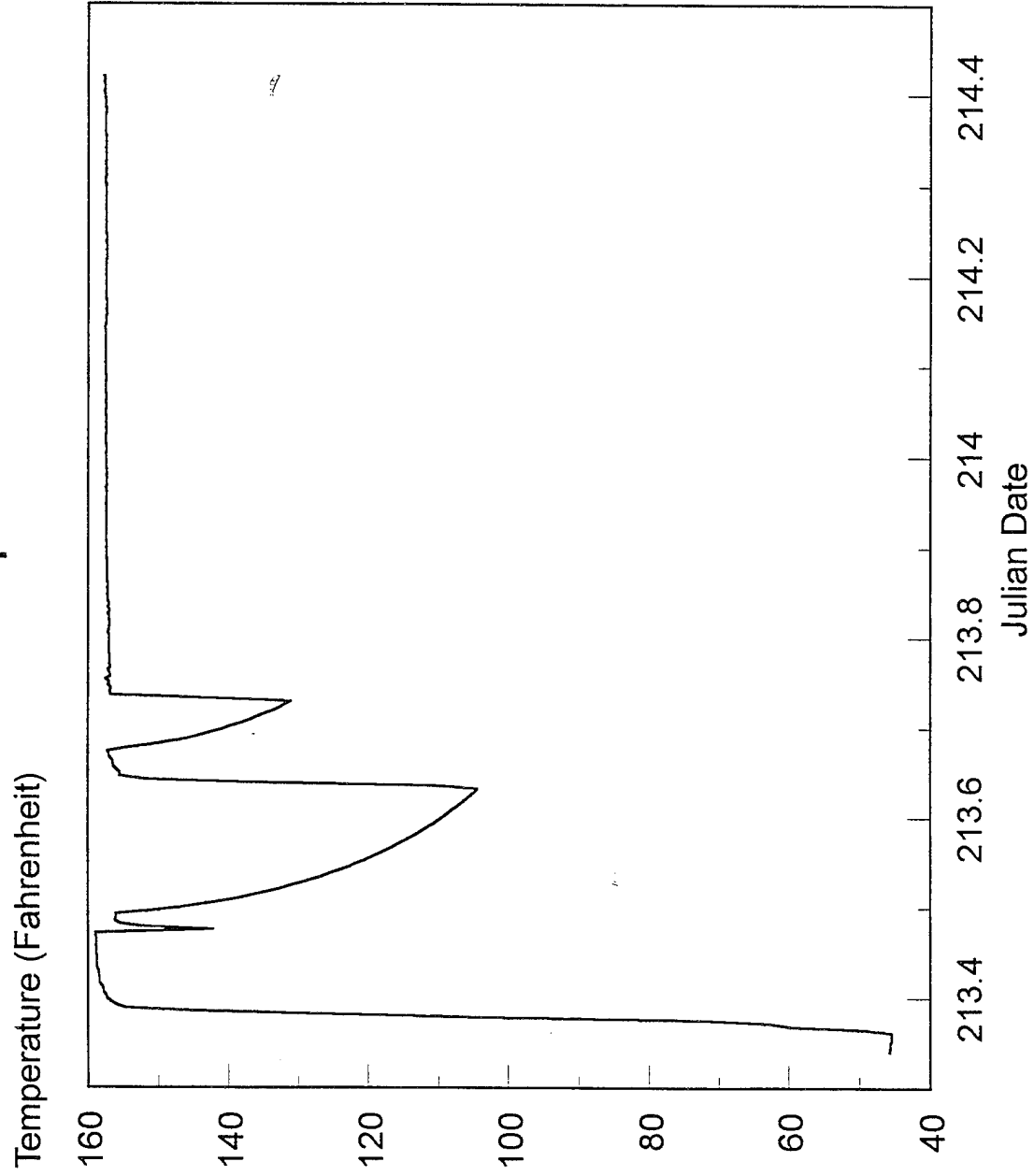


Time of Sample

Seconds X 1.0000

Long. Drop Accel.  
Nuclear Container  
Gs X 1.0000

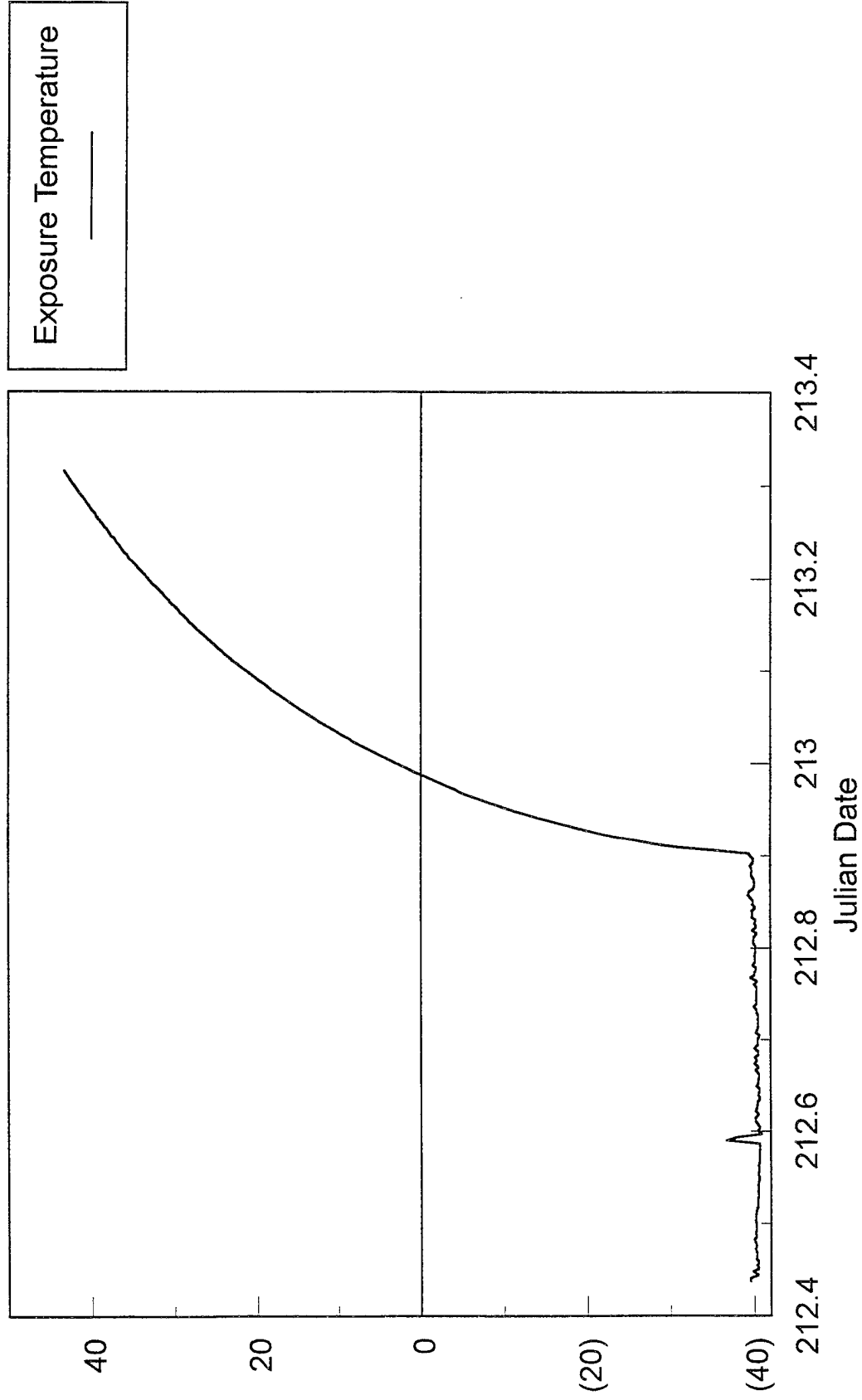
# 55 Gallon Depleted Uranium Shielded Container Chamber Temperatures for Heat Soak Test



Exposure Temperature \_\_\_\_\_

# 55 Gallon Depleted Uranium Container Chamber Temperatures for Cold Soak Test

Temperature (Fahrenheit)





## PART 8

### RADIOGRAPHIC SURVEYS



# X-R-I TESTING

DIVISION OF X-RAY INDUSTRIES, INC.

Test 1

Yellow Drum  
MR/HR @Contact With Drum

| Initial Reading | After Cold | After Heat 4@12:00 | After Heat 3@12:00 | After Side Drop 1@12:00 | After Side Drop 4@12:00 | After Lid Drop 3@12:00 | After Lid Drop 4@12:00 |
|-----------------|------------|--------------------|--------------------|-------------------------|-------------------------|------------------------|------------------------|
| 3.5             | 3.5        | 4                  | 5                  | 3                       | 3.5                     | 4                      | 2.5                    |
| 7.5             | 5.5        | 5                  | 5.5                | 4.5                     | 6                       | 4.5                    | 4                      |
| 5.0             | 6          | 5.5                | 5                  | 5.5                     | 5                       | 4.5                    | 3.5                    |
| 2.5             | 4          | 3.5                | 4                  | 4                       | 3                       | 4                      | 3                      |
| 17.5            | 14.5       | 16                 | 17                 | 17                      | 14                      | -                      | 12                     |
| 75.0            | 70         | 65                 | 70                 | 75                      | 60                      | -                      | 50                     |
| 11              | 10         | 10.5               | 10                 | 12                      | 9                       | -                      | 8                      |
| 35              | 40         | 35                 | 36                 | 32                      | -                       | 35                     | -                      |
| 225             | 300        | 350                | 350                | 260                     | -                       | 300                    | -                      |
| 30              | 35         | 25                 | 32                 | 25                      | -                       | 25                     | -                      |
| 80              | 80         | 80                 | 85                 | -                       | 70                      | 70                     | 60                     |
| 750             | 750        | 850                | 750                | -                       | 700                     | 750                    | 550                    |
| 50              | 45         | 53                 | 62                 | -                       | 55                      | 60                     | 35                     |
| 20              | 25         | 26                 | 22                 | 20                      | 25                      | 20                     | 20                     |
| 140             | 150        | 250                | 200                | 125                     | 250                     | 200                    | 130                    |
| 16              | 19         | 20                 | 17                 | 15                      | 20                      | 15                     | 15                     |
| 1.5             | 2.0        | 1.7                | 1.5                | 1                       | 1.5                     | 1                      | 1                      |
| 2.5             | 3          | 3.7                | 2.5                | 2                       | 2                       | 2                      | 1                      |
| 3.0             | 2.5        | 3.5                | 2.0                | 2                       | 2                       | 2                      | 1                      |
| 1.0             | 0.5        | 1.5                | 1.5                | 1                       | 1                       | 2                      | 1                      |
| 3.0             | 3          | 5                  | 3.5                | 3.5                     | 2.5                     | 2                      | 1                      |

\* GREATER THAN 20% ↑



# X-R-I TESTING

DIVISION OF X-RAY INDUSTRIES, INC.

Test 1

Red Drum  
MR/HR Contact With Drum

| IN  | After<br>Compress | After<br>Vibrate |     | #3<br>@10:00 | #1<br>@12:00 | #2<br>@12:00 | After 3rd<br>Vibration<br>#19<br>@12:00 | After 3rd<br>Vibration<br>#20<br>@12:00 | After Corner<br>Drop |             |
|-----|-------------------|------------------|-----|--------------|--------------|--------------|---|---|----------------------|-------------|
|     |                   |                  |     |              |              |              |   |   | 4<br>@12:00          | 3<br>@12:00 |
| 2.5 | 2                 | 2                | 3   | 3            | 2.5          | 2.6          | 2.5                                     |   | 3                    | 4           |
| 2.0 | 4                 | 2                | 3.5 | 4.5          | 3.0          | 3.3          | 2.5                                     |   | 3                    | 3.5         |
| 2.0 | 4.5               | 3                | 3.5 | 5.5          | 4.5          | 4            | 4                                       |   | 3.5                  | 4.5         |
| 2.5 | 3.5               | 2.5              | 2.5 | 4            | 3.5          | 4            | 3                                       |   | 2.5                  | 3           |
| 20  | 20                | 21               | 17  | 17           | 25           | 15           | 18                                      | 25                                      | 15                   | -           |
| 250 | 250               | 250              | 200 | 75           | 250          | 200          | 125                                     | 200                                     | 125                  | -           |
| 15  | 14                | 16               | 15  | 12           | 15           | 15           | 16                                      | 15                                      | 15                   | -           |
| 30  | 35                | 40               | 35  | 32           | 37           | 35           | 40                                      | 32                                      | -                    | 22          |
| 400 | 350               | 450              | 400 | 260          | 400          | 450          | 425                                     | 350                                     | -                    | 350         |
| 30  | 25                | 35               | 30  | 25           | 25           | 35           | 30                                      | 22                                      | -                    | 24          |
| 30  | 37                | 40               | 45  | -            | 43           | 45           | 39                                      |   | 40                   | 55          |
| 450 | 410               | 400              | 440 | -            | 450          | 450          | 400                                     |   | 400                  | 500         |
| 35  | 28                | 30               | 32  | -            | 32           | 30           | 25                                      |   | 25                   | 30          |
| 25  | 25                | 20               | 20  | 20           | 20           | 20           | 22                                      |   | 30                   | 20          |
| 250 | 250               | 250              | 240 | 125          | 200          | 250          | 250                                     |   | 300                  | 225         |
| 25  | 25                | 21               | 22  | 15           | 20           | 16           | 15                                      |   | 20                   | 15          |
| 2.5 | 2.5               | 2.5              | 1   | 1            | 2.5          | 2.5          | 2.5                                     |   | 1.5                  | 1           |
| 3   | 3.0               | 3.5              | 2   | 2            | 1.5          | 2.7          | 2.5                                     |   | 1.5                  | 1           |
| 2.5 | 2.5               | 2                | 2.5 | 2            | 1.5          | 2.3          | 1.5                                     |   | 2.0                  | 1.5         |
| 3.5 | 2.5               | 3                | 2.5 | 1            | 1.5          | 2.0          | 1.5                                     |   | 1.5                  | 2.0         |
| 4.5 | 3.5               | 5                | 3.5 | 3.5          | 3.5          | 3.5          | 3                                       |   | 2                    | 2           |

\* GREATER THAN 20% ↑

# **BLUE NUCLEAR CONTAINER DECEMBER 1995**

Before Test

|          | Control #1<br><br>12/12/95 | Control #2<br><br>12/12/95 | Post<br>Compression<br>Test<br><br>12/13/95 | Post<br>Vibration<br>Test<br><br>12/14/95 | Post Drop<br>Test<br>(Vertical)<br><br>12/14/95 |           |
|----------|----------------------------|----------------------------|---|---|---|-----------|
| Location | Reading 1                  | Reading 2                  | Reading 3                                   | Reading 4                                 | Reading 5                                       | Reading 6 |
| 1        | < 5mR                      | < 5mR                      | < 5mR                                       | < 5mR                                     | < 5mR   |           |
| 2        | < 5mR                      | < 5mR                      | < 5mR                                       | < 5mR                                     | < 5mR   |           |
| 3        | < 5mR                      | < 5mR                      | < 5mR                                       | < 5mR                                     | < 5mR   |           |
| 4        | < 5mR                      | < 5mR                      | < 5mR                                       | < 5mR                                     | < 5mR   |           |
| 5        | 5 mR                       | 5 mR                       | 5 mR  | 5 mR                                      | 5 mR  |           |
| 6        | 40 mR                      | 40 mR                      | 40 mR                                       | 40 mR                                     | 40 mR   |           |
| 7        | < 5mR                      | < 5mR                      | < 5mR                                       | < 5mR                                     | < 5mR   |           |
| 8        | < 5mR                      | < 5mR                      | < 5mR                                       | < 5mR                                     | < 5mR   |           |
| 9        | 40 mR                      | 40 mR                      | 38 mR                                       | 38 mR                                     | 40 mR   |           |
| 10       | < 5mR                      | < 5mR                      | < 5mR                                       | < 5mR                                     | < 5mR   |           |
| 11       | 5 mR                       | 5 mR                       | < 5mR                                       | < 5mR                                     | < 5mR   |           |
| 12       | 50 mR                      | 50 mR                      | 50 mR                                       | 50 mR                                     | 50 mR   |           |
| 13       | < 5mR                      | < 5mR                      | < 5mR                                       | < 5mR                                     | < 5mR   |           |
| 14       | 5 mR                       | 5 mR                       | < 5mR                                       | < 5mR                                     | 5 mR  |           |
| 15       | 50 mR                      | 50 mR                      | 48 mR                                       | 49 mR                                     | 49 mR   |           |
| 16       | < 5mR                      | < 5mR                      | < 5mR                                       | < 5mR                                     | < 5mR   |           |
| 17       | < 5mR                      | < 5mR                      | < 5mR                                       | < 5mR                                     | < 5mR   |           |
| 18       | < 5mR                      | < 5mR                      | < 5mR                                       | < 5mR                                     | < 5mR   |           |
| 19       | < 5mR                      | < 5mR                      | < 5mR                                       | < 5mR                                     | < 5mR   |           |
| 20       | < 5mR                      | < 5mR                      | < 5mR                                       | < 5mR                                     | < 5mR   |           |

# YELLOW NUCLEAR CONTAINER DECEMBER 1995

Before Test

|          | Control #1<br><br>12/12/95 | Post<br>Heat<br>Test<br><br>12/13/95 | Post<br>Vibration<br>Test<br><br>12/14/95 | Post Drop<br>Test<br>(Horizontal)<br><br>12/14/95 |           |           |
|----------|----------------------------|--------------------------------------|---|---|-----------|-----------|
| Location | Reading 1                  | Reading 2                            | Reading 3                                 | Reading 4   | Reading 5 | Reading 6 |
| 1        | < 5mR                      | < 5mR                                | < 5mR                                     | < 5mR   |           |           |
| 2        | < 5mR                      | < 5mR                                | < 5mR                                     | < 5mR   |           |           |
| 3        | < 5mR                      | < 5mR                                | < 5mR                                     | < 5mR   |           |           |
| 4        | < 5mR                      | < 5mR                                | < 5mR                                     | < 5mR   |           |           |
| 5        | 5 mR                       | 5 mR                                 | 5 mR                                      | 5 mR  |           |           |
| 6        | 57 mR                      | 55 mR                                | 55 mR                                     | 55 mR   |           |           |
| 7        | < 5mR                      | < 5mR                                | < 5mR                                     | < 5mR   |           |           |
| 8        | 5mR                        | 5mR                                  | 5mR                                       | 5mR   |           |           |
| 9        | 50 mR                      | 50 mR                                | 50 mR                                     | 50 mR   |           |           |
| 10       | < 5mR                      | < 5mR                                | < 5mR                                     | < 5mR   |           |           |
| 11       | < 5 mR                     | < 5 mR                               | < 5mR                                     | < 5mR   |           |           |
| 12       | 39 mR                      | 39 mR                                | 35 mR                                     | 38 mR   |           |           |
| 13       | < 5mR                      | < 5mR                                | < 5mR                                     | < 5mR   |           |           |
| 14       | 5 mR                       | 5 mR                                 | < 5mR                                     | < 5mR   |           |           |
| 15       | 40 mR                      | 40 mR                                | 39 mR                                     | 40 mR   |           |           |
| 16       | < 5mR                      | < 5mR                                | < 5mR                                     | < 5mR   |           |           |
| 17       | < 5mR                      | < 5mR                                | < 5mR                                     | < 5mR   |           |           |
| 18       | < 5mR                      | < 5mR                                | < 5mR                                     | < 5mR   |           |           |
| 19       | < 5mR                      | < 5mR                                | < 5mR                                     | < 5mR   |           |           |
| 20       | < 5mR                      | < 5mR                                | < 5mR                                     | < 5mR   |           |           |

**RED NUCLEAR CONTAINER  
DECEMBER 1995**

Before Test

|          | Control #1<br><br>12/12/95 | Post Cold Test<br><br>12/13/95 | Post Vibration Test<br><br>12/14/95 | Post Drop Test (Angle)<br><br>12/14/95 |           |           |
|----------|----------------------------|--------------------------------|-------------------------------------|--|-----------|-----------|
| Location | Reading 1                  | Reading 2                      | Reading 3                           | Reading 4                              | Reading 5 | Reading 6 |
| 1        | < 5mR                      | < 5mR                          | < 5mR                               | < 5mR                                  |           |           |
| 2        | < 5mR                      | < 5mR                          | < 5mR                               | < 5mR/                                 |           |           |
| 3        | < 5mR                      | < 5mR                          | < 5mR                               | < 5mR                                  |           |           |
| 4        | < 5mR                      | < 5mR                          | < 5mR                               | < 5mR                                  |           |           |
| 5        | 5 mR                       | 5 mR                           | 5 mR                                | 5 mR                                   |           |           |
| 6        | 42 mR                      | 40 mR                          | 45 mR                               | 44 mR                                  |           |           |
| 7        | < 5mR                      | < 5mR                          | < 5mR                               | < 5mR                                  |           |           |
| 8        | 5mR                        | 5mR                            | 5mR                                 | 5mR                                    |           |           |
| 9        | 48 mR                      | 48 mR                          | 45 mR                               | 49 mR                                  |           |           |
| 10       | < 5mR                      | < 5mR                          | < 5mR                               | < 5mR                                  |           |           |
| 11       | 5 mR                       | 5 mR                           | < 5mR                               | < 5mR                                  |           |           |
| 12       | 49 mR                      | 48 mR                          | 48 mR                               | 48 mR                                  |           |           |
| 13       | < 5mR                      | < 5mR                          | < 5mR                               | < 5mR                                  |           |           |
| 14       | 5 mR                       | 5 mR                           | < 5mR                               | 5mR                                    |           |           |
| 15       | 50 mR                      | 49 mR                          | 49 mR                               | 50 mR                                  |           |           |
| 16       | < 5mR                      | < 5mR                          | < 5mR                               | < 5mR                                  |           |           |
| 17       | < 5mR                      | < 5mR                          | < 5mR                               | < 5mR                                  |           |           |
| 18       | < 5mR                      | < 5mR                          | < 5mR                               | < 5mR                                  |           |           |
| 19       | < 5mR                      | < 5mR                          | < 5mR                               | < 5mR                                  |           |           |
| 20       | < 5mR                      | < 5mR                          | < 5mR                               | < 5mR                                  |           |           |

PART 9

APPENDIX

CUSTOMER: CONAM INSPECTION INC

CAL1

**NDS PRODUCTS, INC**

P.O.BOX 1896  
PASADENA TEXAS 77501  
PHONE: (713) 475-2986

**CALIBRATION CERTIFICATE**  
TEXAS LICENSE # L00991

111 ANDERSON  
PASADENA TEXAS 77506  
FAX: (713) 477-6741

INSTRUMENT: CONAM INSPECTION INC  
OWNER 1245 W NORWOOD AVE  
ITASCA IL 60143

ORDER NR.: 52961  
MFG: NDS PRODUCTS INC  
MODEL: ND-200P  
SERIAL NR.: 19122

CALIBRATION DATE: 06-DEC-1995

CALIBRATION DUE DATE: 06-MAR-1996

T. 70DEG. F. R.H. 59 % B.P 762.53 mm Hg  
Y:HIGH & LOW VOLTAGES CHECKED Y:BATTERIES CHECKED  
Y:CURRENT DRAIN CHECKED Y:REPLACED WITH: EN95  
Y:SATURATION > 15 R/hr Y:METER ZEROED Y:GEOTROPISM CHECKED  
:INSPECTED FOR DAMAGE :PROBE MODEL & S/N: EW101-01 10005  
Y:TIGHTENED LOOSE HARDWARE Y:PROPER FUNCTIONING ASSURED  
PARTS REPLACED:

COMMENTS: CALIBRATED WITH DETECTOR WINDOW FACING SOURCE

NDS PRODUCTS CERTIFIES THAT THE ABOVE INSTRUMENT HAS BEEN CALIBRATED BY STANDARDS TRACEABLE TO N.I.S.T.. THE CALIBRATION SYSTEM CONFORMS TO THE REQUIREMENTS OF MIL-STD-45662, ANSI-N323-1978, N.R.C. 10 CFR PART 34.24, 10CFR 39.33, TEXAS TCR PART 46.5, PART 31.5, AND PART 36.13. NEW MEXICO REG. NO. 271-3. ARKANSAS REG. NO. VS0386.

CALIBRATED TO Cs-137 0.662 MeV S/N 310, NIST TEST NO. DG8953/89, DG8639/87 AND DG8640/87  
CALIBRATED BY NOEL D. SMITH RSO Q.A. MANAGER, KEVIN E. SMITH Q.A. TECH., OR QUINTIN STOKLEY Q.A. TECH.

SIGNATURE: 

DATE: 06-DEC-1995

| INSTRUMENT RANGE mR/hr                               | INSTRUMENT READING mR/hr                      | CAL. REFERENCE POINT mR/hr                                | AS RECEIVED READING mR/hr                     |
|--|---|---|---|
| 0 - 10,000<br>0 - 1000<br>0 - 100<br>0 - 10<br>0 - 1 |   | 2000 - 8000<br>200 - 800<br>20 - 80<br>2 - 8<br>0.2 - 0.8 |   |
| 0 - 2000<br>0 - 200<br>0 - 20<br>0 - 2<br>0 - 0.2    | 55 - 150<br>5.2 - 15.0<br>0.52 - 15.0<br>0.10 | 500 - 1500<br>50 - 150<br>5 - 15<br>0.5 - 1.5<br>0.10     | 58 - 170<br>4.8 - 14.0<br>0.52 - 15.0<br>0.10 |
| 0 - 500<br>0 - 50<br>0 - 5<br>0 - 0.5                |   | 100 - 400<br>10 - 40<br>1 - 4<br>0.1 - 0.4                |   |
|  |   |   |   |





Consultants to Nuclear Medicine • Radiology • Nuclear Industry

STAN A. HUBER CONSULTANTS, INC. □ 200 NORTH CEDAR ROAD □ NEW LENOX, IL 60451 □ (815) 485-6161 □ FAX (815) 485-4433

December 15, 1994

U.S. Army Armament  
Munitions and Chemical Command  
Attn: Walter Prisk, AMSMC-DSM-E, DSN 793-5974  
Rock Island, Illinois 61299-6000

RE: Suggestion for Feasibility Analysis

Subject: **Proposal to use some of AMCCOM Depleted Uranium as Shielding Material  
at Russian Reactor Incident Sites**

Dear Mr Prisk:

This proposal is a suggested additional usage of Depleted Uranium (D.U.) projectiles of AMCCOM, in addition to our already pending proposal to manufacture D.U. shielded containers for use at U.S. government facilities or the private sector, for shielding of radioactive materials in storage, transport or disposal. The basic products we previously proposed are 30 and 55 gallon sized drums, although 19 gallon and other sizes are feasible. We manufactured a prototype 30 gallon shielded container, tested its performance and issued a feasibility report to AMSMC-PCC/Ms Demi Owens; Rock Island, Illinois dated December 30, 1993.

### **Background**

The continuing radiation hazards at Chernobyl, Chelyabynsk and other locations in Russia are well known. Stan A. Huber Consultants, Inc. has already been contacted by a U.S. firm which has a twenty (20) year license to ship NORM (Naturally Occurring Radioactive Material) to Chernobyl for use as shielding material.

### **Objective**

Our opinion is that Depleted Uranium could be used to provide much improved shielding at locations such as Chernobyl and could perhaps save lives and at least aid in preventing further radiation releases or unnecessary radiation exposures. At the same time, the U.S. could obtain good-will by providing effective shielding blocks and convert much of its unneeded D.U. stockpile into usable products instead of incurring storage costs and exorbitant waste disposal fees.

### The Proposed Product

The proposed product would be a 44 gallon square container, "block shield" filled with D.U. projectiles and concrete. The reason for the square shape is to avoid shielding gaps that would otherwise occur with typical round barrels. Also, Stan A. Huber Consultants, Inc. knows that 44 gallon square containers are commercially available, although quotes for other size square drums and lids could also be obtained. It may be possible to use round drums, if they are staggered properly at the usage areas to be shielded.

### The Projected Costs

Other than the cost of materials and labor, we know a firm that could transport the finished block shields to Chernobyl for an estimated \$45 per cubic foot. This is considerably less expensive than the combination of transport and disposal costs within the U.S. Of course, it is possible that the U.S. Government or Army would want to do its own transport of the finished block shields to Chernobyl, if it believes it can do those transport, export, and moving activities for lower costs. This estimated cost data is provided as a ball-park figure for discussion purposes.

### Manufacturing

It should be much easier to make the completely filled "block shields" compared to the D.U. shielded containers, because there is no need for creating content cavities in the drums with pipes or Sono tubes. Therefore, the cost per item would be reduced, compared to shielded drums. (It may be possible to use such block shields at DOE facilities)

### Recommendation

We recognize this proposed use of part of the AMCCOM stock pile of D.U. projectiles falls in the categories of international good- will, foreign aid or diplomatic politics. However, it seems worthwhile to suggest this concept to the appropriate managers and political contacts, to determine their perceptions of the merits and feasibility.

Respectfully submitted,



Stan A. Huber  
President

SAH:jjz

# **sahci**

## **Stan A. Huber Consultants, Inc.**

### **Health Physics and Radiation Safety Services**

200 N. Cedar Road — New Lenox, IL 60451-1751

1 (800) 383-0468 or 1 (815) 485-6161 FAX 1 (815) 485-4433

<http://www.pchydram.com/sahci> — E.mail: SSQC17A@Prodigy.com

## **FAX TRANSMISSION COVER SHEET**

|  |                      |
|--|----------------------|
| Date:  | 12/8/95              |
| To:  | Bill Meyer SIOAC-DEV |
| Facility:  | US Army              |
| Fax Number:  | 815-273-8811         |
| From:  | Joel Ahrweiler       |
| No. of Pages (Including Cover Sheet)                         | 18                   |
| IF ALL PAGES ARE NOT RECEIVED,<br>PLEASE CALL (815) 485-6161 |                      |

### **MEMO:**

|  |
|--|
| Bill here is a copy of the latest D.U.           |
| Drum Procedure, also attached are the MSDS       |
| sheet for Portland type 1 cement & Fine Hematite |
| aggregate  |
|  |
|  |
|  |

## **Stan A. Huber Consultants, Inc.**

200 North Cedar Road  
New Lenox, IL 60451

Phone:(815) 485-6161 Fax:(815) 485-4433

# **55 Gallon Depleted Uranium Shielded Container**

## **Procedure Manual**

**--Proprietary--**

updated 10-06-95 Page 1

## ***Table of Contents***

|   |           |
|---|-----------|
| <b>MATERIAL LIST . . . . .</b>                    | <b>3</b>  |
| <b>MIXING THE HIGH DENSITY CONCRETE . . . . .</b> | <b>5</b>  |
| <b>POURING THE BASE . . . . .</b>                 | <b>6</b>  |
| <b>FILLING THE OUTER WALLS . . . . .</b>          | <b>7</b>  |
| <b>APPLYING THE D.U. PROJECTILES . . . . .</b>    | <b>8</b>  |
| <b>POURING THE LID . . . . .</b>                  | <b>9</b>  |
| <b>CURING PROCESS . . . . .</b>                   | <b>10</b> |
| <b>DIAGRAM OF COMPLETED CONTAINER . . . . .</b>   | <b>11</b> |

## **55 GALLON DEPLETED URANIUM SHIELDED CONTAINER - MATERIAL LIST**

**(1) 55 GALLON DRUM - UN SPEC. A2/Y1.5/150/91, Steel, black**

Supplier: Skolnick Industries, Inc. or equivalent UN SPEC# Drum supplier

Dean Ricker

4900 S Kilbourn Ave.

Chicago, IL 60632-4593

(312) 735-0700

**(130 lbs) PORTLAND CEMENT - TYPE ONE, manufactured by Essroc, 94 lb bags**

Supplier: Handy Andy or other hardware store

**(345 lbs) FINE HEMATITE AGGREGATE**

Supplier: Nuclear Shielding Supplies and Service

Manjit Chopra

45656 S Palo Verde, Suite 203

Tucson, AZ 85714

(602) 748-9362

**(6 oz.) SUPER PLASTICIZER - DARACEN 100**

Supplier: Meyer Material or other supplier of DARACEN 100

RR 1 Bluff Rd

Channahon, IL 60410

(815) 467-2236

**(1) 10" SONO TUBE - 3/16" thick fibre form, 23 inches long**

Supplier: McCann Construction Specialties Company \*

303 Republic Ave.

Joliet, IL 60435-6519

(815) 744-5511

**(1) 16" SONO TUBE - 1/4" thick fibre form, 28 inches long**

Supplier: McCann Construction Specialties Company \*

303 Republic Ave.

Joliet, IL 60435-6519

(815) 744-5511

**--Proprietary--**

updated 10-06-95 Page 3

(143 lbs) SAND - coarse, all purpose, Torpedo brand, 50 lb bags

Supplier: Smith Brothers Garden Center \*

2601 E Lincoln Highway

New Lenox, IL 60451

(815) 485-9420

(260 lbs) COARSE AGGREGATE - 5/8" Diameter Meramec stone (small)

Supplier: Smith Brothers Garden Center \*

2601 E Lincoln Highway

New Lenox, IL 60451

(815) 485-9420

(2) EYE BOLTS - 1/2" x 4" Thread Length

Supplier: Handy Andy or other Hardware Store

(2) NUTS - 1/2" Thread (for use w/ Eye Bolts)

Supplier: Handy Andy or other Hardware Store

(4) WASHERS - 2" Diameter (for use w/ Eye Bolts)

Supplier: Handy Andy or other Hardware Store

(300) DEPLETED URANIUM PROJECTILES - (# is approximate,  $280 \pm 60$  projectiles)

Supplier: US Army

Projectiles are used as aggregate,  
similar to gravel stones with cement  
to make concrete.

(52 lbs) WATER - (amount not in gallons, so weight is approximate)

\*= or equivalent construction goods supplier

**--Proprietary--**

updated 10-06-95 Page 4

## **MIXING THE HIGH DENSITY CONCRETE**

In order to mix the batch of concrete, a large basin or concrete mixer will be needed. The following materials compose 1 batch of high density concrete:

| INGREDIENT                       | AMOUNT IN LBS |
|----------------------------------|---------------|
| Portland Cement                  | 10 *          |
| Water                            | 6 *           |
| Coarse Aggregate (5/8" Diameter) | 20 *          |
| Sand                             | 11 *          |
| Fine Hematite                    | 26.5 *        |
| Super Plasticizer                | 0.5 oz        |

\* The above amounts can easily be varied by at least  $\pm 20$  % for each item, depending upon such factors as humidity and or dryness or physical characteristics of the cement aggregate, sand, and hematite.

The batch can be any size, just as long as the ingredients are a multiple of the above amounts. For example, if you were going to produce several drums and did not want to mix up each batch individually, you could multiply all of the ingredients by 2 or any other number that gives you a workable batch size.

All of the ingredients should be mixed by hand or machine until there is no standing water. There should not be any unmixed portions in the batch and the result should be a cement-like homogeneous mixture. For optimal performance, the concrete should be mixed in temperatures between 50 and 80 degrees Fahrenheit. Mixing the concrete in extreme temperatures will affect the curing process.

After curing, the water will have dried up. The 67.5 lb. batch of concrete will need 6 lbs. of water. The ingredients should be composed of these approximate percentages, by weight:

|                   |       |
|-------------------|-------|
| Portland cement   | 14.8% |
| Coarse Aggregate: | 29.6% |
| Sand:             | 16.3% |
| Fine Hematite:    | 39.3% |

The plasticizer does not have an effect on the overall weight of the container, but it aids in the curing process. The plasticizer is one ingredient of the mix that needs to be weighed out very precisely. There should not be more than 1 oz. of plasticizer per 100 lbs of mix.



## POURING THE BASE

Once the high density concrete has been mixed, the base of the drum should be created. Carefully, pour the mixture into the 55 gallon drum until there are 4 inches of concrete. After 4 inches of concrete are poured, the drum needs to be shaken manually, or vibrated. It is essential that all air pockets are removed, because any gaps will take away from the shielding potential of the container.

The drums must be manufactured on a level surface. If the concrete is poured on a non-uniform surface, the performance of the drum will be greatly reduced. It is a good idea to build the drums on pallets so that they can be transported easier later. Using a fork truck to lift the drums individually before they have cured could cause damage to the different layers. The completed container will weigh up to 1600 lbs and can not be transported very easily without the proper equipment.

After the first four inches of concrete have been poured, the first sono tube needs to be placed. Take the 16" diameter sono tube and place it directly in the center of the drum. The sono tube must be centered so that the distance between the sono tube and the drum are equal all the way around. Any variation will have a significant effect on the shielding capabilities.

The sono tube needs to be placed at a 90 degree angle to the base of the drum. Once the sono tube is centered and leveled, push the tube 2 inches into the concrete base. To double check the alignment of the sono tube, measure the distances between the tube and the drum again, and use a level to make sure it is at the correct angle.

## **FILLING THE OUTER WALLS**

Up to this point, the base of the container has been poured and the outer sono tube is firmly in place. The next step is to complete the outer walls and insert the inner wall.

Make up several more batches of high density concrete. Take the mixture and carefully fill up the outer wall between the sono tube and the drum. Fill the sides with concrete until it is even with the top of the 16" sono tube. The sono tube might be knocked slightly out of place during this process, so measurements and a level test should be taken as a precaution. This outer wall of high density concrete will be approximately 3 1/2 inches wide, all the way around the container.

After the concrete has been poured and is even with the sono tube it should also be within 2 to 3 inches from the top of the drum, now you will need to insert the inner sono tube. This tube should also be centered and leveled. Follow the same steps that were taken to insert the first tube. Carefully, insert the 10" sono tube into the base, which should still be wet. Push it firmly into place, once again checking that the distances between the inner sono tube and the outer sono tube are equal all the way around.

At this time you will have the base and the outside walls poured with both the 16" sono tube and the 10" sono tube in place.

**--Proprietary--**

updated 10-06-95 Page 7

## APPLYING THE D.U. PROJECTILES

This step is the most difficult to perform. The D.U. projectiles are part of the nuclear shielding, so there will be three inches of high density concrete and projectile mix on all sides and the bottom. Later, when the lid is manufactured, it too will have three inches of high density concrete and projectiles mix.

Start by filling the bottom of the inner cavity with projectiles three inches deep. Due to the fact that the sono tube diameters can vary up to an inch in size, the exact number of projectiles can only be estimated at 26 ( $\pm 5$  projectiles) for the inner cavity base. There should be an attempt made to fit as many projectiles in the allotted 3 inch space as possible. There will be small gaps in between the D.U. projectiles so a small amount of concrete will have to be applied. All of the gaps between the projectiles must be filled with concrete to assure optimum performance of the finished container. Because the concrete has to fill the gaps, a special concrete mixture has to be used. Fine hematite will be increased to 46.5 lbs. per batch and coarse aggregate will be eliminated. Other than increasing the fine hematite and eliminating the coarse aggregate, the mixture is exactly the same as it was for constructing the outside cavity and the base.

At this time there will be a solid base of concrete and D.U. projectiles mix three inches deep. This fills three inches of the inner cavity. Next, the walls of the middle cavity will need to be constructed.

Place about 30 D.U. projectiles around the middle cavity. Then pour a small amount of high density concrete mixture to fill in the gaps between the projectiles. The projectiles are to be treated as aggregate in a concrete mix so the exact placement is not of importance other than the fact that it is desirable to use as many projectiles as possible. Repeat these steps of placing projectiles and filling the gaps until you near the top of the container. Stop filling the walls with D.U. when you are an inch away from the top of the 10 inch sono tube. This inch should be filled with high density concrete only. Once again, due to sono tube variation the exact number of projectiles can only be estimated at 225 ( $\pm 45$  projectiles) for the container walls only. This middle layer will be approximately 3 inches wide all the way around the container.

The D.U. projectile layer will be five inches shorter than the outside concrete layer, and between seven and eight inches from the top of the drum.

At this time you should have an outside wall of high density concrete (2 to 3 inches from the top of the drum), a middle wall of high density concrete and D.U. projectiles mix (7 to 8 inches from the top of the drum), and an inner cavity. The gap left over between the outer wall and the inner wall will be filled by the lid. ( to be constructed later)

## POURING THE LID

When mass producing shielded containers, a wooden form would be used to make the lids. However, using a scrap piece of sono tube is much more efficient when only building a few containers. Both the cardboard sono tube and the wooden form produce the same lid, so the following process can be followed for both.

If you don't have a wooden form, take a 16 inch sono tube and cut a small strip out of the tube from top to bottom. Re-attach the two free sides of the sono tube with duct tape. In a sense you will be creating a 15 1/2 inch sono tube. A regular 16 inch sono tube can not be used because the lid needs to fit inside the outer wall, and be able to be removed easily.

Take the newly created 15 1/2 inch sono tube and attach it to a piece of wood or cardboard on a flat, level surface with a layer of sheet plastic between. Instead of having a wooden form, you have created a cardboard form that can be discarded after production of the lid.

First, pour one inch of high density concrete into the bottom of the form. Then take D.U. projectiles and place them laying down (just like the base). However, in the case of the lid, one inch of concrete will need to be around the outside of the lid. There should not be any projectiles within one inch of any wall of the lid. Fill in the gaps and the outside inch with high density concrete. Repeat this step three times, each time constructing another layer.

At this time, the bottom inch will be all high density concrete and the next three inches D.U. projectiles and concrete. Finish the lid off by pouring one inch of high density concrete over the top of the form. The finished lid will be approximately 15 1/2 inches in diameter and 5 to 5 1/2 inches tall. The core of the lid will be made of approximately 32 ( ± 6 ) D.U. projectiles, while the outside inch of the entire lid will be concrete only.

The last step is to take the Eye bolts with the washers and nuts and insert them into the lid with the eyes exposed. Once the concrete has cured, the eye bolts will provide handles, so the lid can be moved when necessary. The finished lid will fit inside the outer wall, sitting on top of the middle wall.

## **CURING PROCESS**

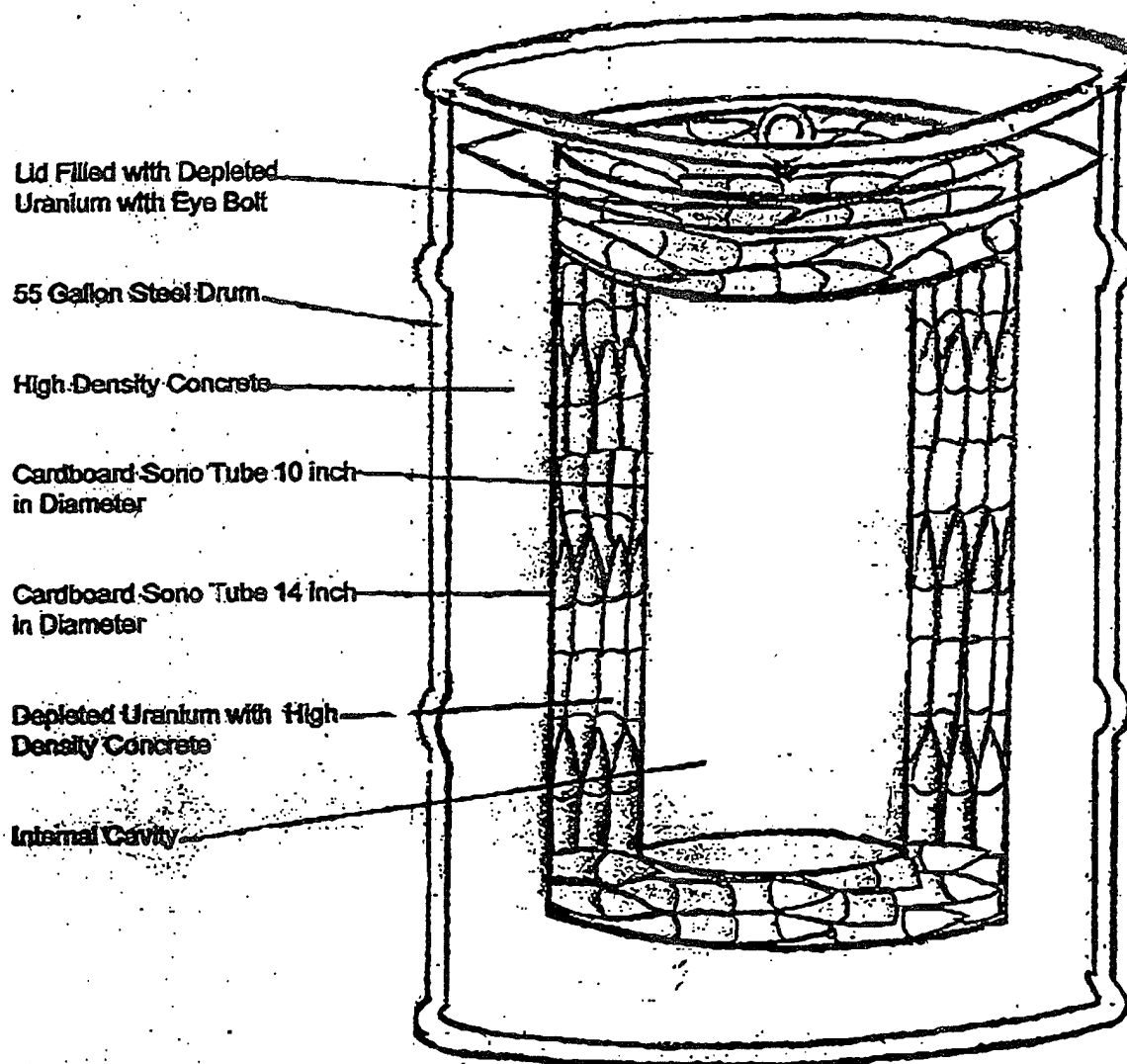
There are several things that will help the containers to cure properly. First of all, the containers should not be moved for at least 48 hours. After two days the concrete will be fairly secure but still should not be transported. The container takes a full twenty-eight days to cure totally. After that time they can be moved freely and used to store and transport radioactive materials.

The twenty-eight day curing time the containers should be stored in a dry place. Do not put the lids on the containers because the water will need to evaporate from the concrete. Sealing or covering the drum will greatly extend the curing process.

The containers also should be kept in the same temperatures in which they were built (between 50 and 80 degrees). Freezing temperatures during the curing process could cause the concrete to crack. The containers should also not be exposed to water.

After the containers are completed they need to be labeled "Caution - Radioactive Shielding Uranium". See attached sample label. Stencililing can also be used. Height of letters in the label is not specified in the regulations [Title 10 CFR Part 40.13 (c)(6)(i)].

## DIAGRAM OF COMPLETED CONTAINER



**NOTE:** The side walls of D.U. shown on the above sketch show the projectiles to be neatly stacked vertically. In manufacturing, it is neither projectile nor necessary to arrange the projectiles in this manner, since they are as aggregate, similar in density to the high density concrete.

**--Proprietary--**

updated 10-06-95 Page 11

12/08/95

11:21

002



# Material Safety Data Sheet

## [OSHA 29 CFR 1910.1200]

### IDENTITY

Product Name: Portland Cement (Type I, II or IA)  
Product Code: 1124

### SECTION I

#### Manufacturer's Name and Address

The QUIKRETE Companies  
1790 Century Circle  
Atlanta, Georgia 30345

#### Emergency Telephone Number

(404) 634-9100

#### Information Telephone Number

(404) 634-9100

#### Date of Preparation

January 1, 1988

### SECTION II - HAZARDOUS INGREDIENTS/IDENTITY INFORMATION

| <u>Hazardous Components</u> | <u>CAS No.</u> | <u>OSHA PEL</u> | <u>ACGIH TLV 3 MG/M</u> | <u>Other Limits Recommended</u> |
|-----------------------------|----------------|-----------------|-------------------------|---------------------------------|
|                             | 65997-15-1     |                 | 5                       |                                 |

### SECTION III - PHYSICAL/CHEMICAL CHARACTERISTICS

Solubility in Water - Slight  
Gray colored with no odor

The following properties are not applicable: Specific Gravity, Boiling Point, Vapor Pressure, Vapor Density, Melting Point, Evaporation Rate.

**Material Safety Data Sheet****Page 2**

**Product Name:** Portland Cement (Type I, II or IA)  
**Product Code:** 1124

---

**SECTION IV - FIRE AND EXPLOSION HAZARD DATA**

Noncombustible and not explosive.

---

**SECTION V - REACTIVITY DATA**

Stable

Is not incompatible with other materials, will not decompose into hazardous by-products and will not polymerize.

Keep dry until used to preserve product utility.

---

**SECTION VI - HEALTH HAZARD DATA**

Classified as a nuisance dust by OSHA, MSHA and ACGIH. As such, the TLV is 5 mg/m<sup>3</sup> for respirable dust and 10 mg/m<sup>3</sup> for total dust. Not known to cause cancer. Exposure can affect the skin, the eyes and mucous membranes.

**Acute Exposure:** Can dry the skin and cause alkali burns. Dust can irritate the eyes and upper respiratory system.

**Chronic Exposure:** Dust can cause inflammation of the lining tissue of the interior of the nose and inflammation of the cornea. Hypersensitive individuals may develop an allergic dermatitis.

**Emergency First Aid Procedures:** Irrigate (flush) eyes immediately and repeatedly with clean water. Wash exposed skin areas with soap and water.

---

**SECTION VII - PRECAUTIONS FOR SAFE HANDLING AND USE**

If spilled can be cleaned up using dry methods that do not disperse dust into the air. Avoid breathing the dust. Emergency procedures are not required.

Can be treated as a common waste for disposal or returned to the container for later use if it is not contaminated or wet.

---



**Material Safety Data Sheet****Page 3****Product Name: Portland Cement (Type I, II or IA)****Product Code: 1124**

---

**SECTION VIII - CONTROL MEASURES**

In dusty environments, the use of an OSHA, MSHA or NIOSH approved respirator and tight fitting goggles is recommended.

Local exhaust can be used, if necessary, to control airborne dust levels. The use of barrier creams or impervious gloves, boots and clothing to protect the skin from contact is recommended. Following work, workers should shower with soap and water. Precautions must be observed because burns occur with little warning -- little heat is sensed.

---

DEC-08-1995 09:49

MINERALS RESEARCH

P.02

**NUCLEAR SHIELDING SUPPLIES & SERVICE**4620 SOUTH COACH DRIVE  
TUCSON, ARIZONA 85714

TELEPHONE: (520) 748-9362

FAX: (520) 748-9364

**MATERIAL SAFETY DATA SHEET****GENERAL INFORMATION**

**Manufacturer:** Nuclear Shielding Supplies & Service  
4620 South Coach Drive  
Tucson, Arizona 85714

**Creation Date:** 10/90**Revision Date:** N/A**For Additional Information, Contact:****Phone:** 520/748-9362**Fax:** 520/748-9364**MSDS Code:** H. AGG.F**PRODUCT IDENTIFICATION****Product Name:** High Density Fine Aggregates**Formula:** Fe<sub>2</sub>O<sub>3</sub>**Synonym(s):** NA**Chemical Family:**  
Oxides of (1) Iron  
(Hematite)**TYPICAL CHEMICAL COMPOSITION****General Chemical Analysis (Typical)**

|   |                                |       |
|---|--------------------------------|-------|
| % | Fe                             | 65.93 |
|   | P                              | 0.006 |
|   | SiO <sub>2</sub>               | 5.31  |
|   | Al <sub>2</sub> O <sub>3</sub> | 0.31  |
|   | MgO                            | 0.018 |
|   | CaO                            | 0.015 |
|   | Mn                             | 0.13  |

**Permissible Air Level****OSHA PEL** **ACGIH TL**  
NE NE**Footnotes:**

- (1) See last page for important additional terms and conditions including disclaimer of warranties.
- (2) Concentration may vary somewhat between batches or lots. Where possible, a concentration range is indicated. Occasionally, however, levels may even fall outside of the usual concentration range.
- (3) Common names, if applicable, appear in parenthesis following the chemical names.

MSDS006

DEC-08-1995 09:50

MINERALS RESEARCH

P.03

**Hematite Aggregate (Fine)**

Page 2 of 3

-----**PHYSICAL DATA**-----Physical State: Fine GranularBulk Density: 185 - 210 lbs/ft<sup>3</sup>Appearance and Odor: Gray Color,  
OdorlessVapor Pressure: NABoiling Point: NAVapor Density: NAMelting Point: Over 1200°CEvaporation Rate: NApH: NA-----**FIRE AND EXPLOSION HAZARD DATA**-----Flash Point (Method): NALower Explosive Limit: NAAuto ignition Temperature: NAUpper Explosive Limit: NAFire Hazard: Non FlammableExplosion Hazard: NAExtinguishing Media: NASpecial Fire Fighting Procedures:  
NAUnusual Fire and Explosion Hazards: NA-----**REACTIVITY DATA**-----Stability: StableIncompatibilities (Materials to Avoid):  
Strong mineral acids eg. HCl, H<sub>2</sub>SO<sub>4</sub>,  
HNO<sub>3</sub>.Hazardous Thermal Decomposition Products: None ExpectedPolymerization: Will not occur-----**HEALTH HAZARD DATA**-----

Proper precautions should be taken to avoid any health hazard. A health hazard may occur if limits for air contaminants exceed PEL limits as per 29 CFR 1910.1000. Proper engineering controls and ventilation should be used to prevent air contaminants from exceeding PEL limits. (For information on potentially hazardous elements refer to page 3.)

Usual Route(s) of Entry: InhalationMedical Conditions Possibly Aggravated: Chronic diseases or disorders of the respiratory system.Carcinogen Information: Not considered to be a carcinogen.

DEC-08-1995 09:51

MINERALS RESEARCH

P.04

**Hematite Aggregate (Fine)**

Page 3 of 3

## -----FIRST AID AND MEDICAL EMERGENCY PROCEDURES-----

**Eye Contact:** Not anticipated to pose an acute or significant eye contact hazard.  
**Skin Contact:** Not anticipated to pose an acute or significant skin contact hazard.  
**Inhalation:** Not anticipated to pose an acute or significant inhalation hazard.  
**Ingestion:** Not considered to be an ingestion hazard.

## -----OCCUPATIONAL EXPOSURE CONTROL MEASURES-----

**Engineering Controls (Ventilation, etc.):** Ventilation should be sufficient to maintain dust levels below applicable exposure limit.  
**Work Practices (Handling and Storage, etc.):** Avoid creating airborne dust by dust suppression methods.  
**Eye Protection:** Safety glasses or goggles are recommended when dust levels are excessive.  
**Skin Protection:** Gloves and long-sleeved clothing are recommended when dust levels are excessive.  
**Respiratory Protection:** When engineering controls are not sufficient to lower dust levels below the applicable exposure limit, use a NIOSH-approved respirator for dusts and mists within the use limits of the respirator.

## -----SPILL, LEAK AND DISPOSAL INFORMATION-----

**Procedures to Follow if Material is Released or Spilled:** Material should be swept or vacuumed into appropriate containers.  
**Waste Disposal Method(s):** Landfill disposal or other methods which are in accordance with local, state and federal regulations. Wastes may be reclaimed or salvaged for further use.

## -----ADDITIONAL MISCELLANEOUS INFORMATION-----

NONE

**Abbreviations:**

NA = Not Applicable  
NE = Not Established

The Ilmenite Aggregates do not meet the criteria of hazardous chemicals as defined by the Federal Occupational Safety and Health Hazard Communication Standard 29 CFR 1910.1200 (c). This form is being provided solely as General Information and should not be construed as a determination that the product is a hazardous chemical. All sales of this product are subject to Nuclear Shielding Supplies & Service's standard terms and conditions of sale. NSS makes no warranties, express or implied, including the Implied Warranty of merchantability. Any implied warranty of fitness for a particular purpose or any implied warranties otherwise arising from course of dealing or trade.

MSDS006

TOTAL P.04